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FORESTRY IN GEOGRAPHY.[1]

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To the minds of most of the grown-up persons in the United States the word "geography" probably will bring a vision of a large, flat book, filled with maps in variegated colors, the intervening pages burdened with series upon series of questions and answers beginning something like this: "What is the earth? The earth is the planet upon which we dwell." The chief utility of the "joggerfy" was considered by many of us in those days to be its effectiveness as a shield from the keen watchfulness of the teacher. What we learned from its pages was generally typified by a sing-song recital of the names of the states and their capitals, varied occasionally by an attempt to "bound New Jersey" or to perform some other equally inconsequential and abstract feat of memory. Fortunately, the subject of geography has been to-day, to a large degree, rescued from such treatment, and has been made the medium through which the student learns of the great world about him and of the activities of his fellow men in their endeavors to occupy the face of the earth and make it serve their needs.

THE MEANING OF GEOGRAPHY.

A good old definition of geography is—"The description of the earth's surface and its inhabitants." As definitions go, this is perhaps satisfactory enough. It includes within its scope the study of topographic conditions and formations; how these features are formed and modified; and what are the effects of these features on the lives of men. This last phase is the one which, after all, is the vital element in geography. There would be no especial benefit derived from studying about seas, rivers, mountains, and plains, unless these features had some connection with the life of man. The really living element in geog-

[1]Address delivered at the 1911 session of the Summer School of the University of Virginia.

raphy is the consideration of how man has been able not only to overcome the obstacles placed in the path of his progress by nature, but how the human mind has triumphed over countless difficulties in its struggle to utilize the products of the earth in ministering to man's own comfort. Now the teacher of geography instead of compelling the pupils to memorize which states produce coal, corn, or cotton, asks them to learn the stories of these and other articles of commerce, tracing each from the earliest stages of production to its final consumption. The great rivers of the nation become not merely wiggly black marks on the bright-hued map but the mind of the pupil sees them carrying boats and turning water wheels, or, swollen with the freshet waters of the early spring, carrying destruction to the valleys through which the floods pass, as well as bearing away to the ocean in their turbid waters hundreds of tons of rich silt torn from the hillsides. Thus each feature of the earth's surface takes on a real significance, of greater or lesser importance according to the influence it exerts on the life of man. Thus geography explains and illuminates history. It gives us an insight into the movements of the races; explains the tide of battle in many a hard-fought struggle between the nations; and tells us the secret of the peace and prosperity which attend some nations and the calamities that have befallen others.

From this point of view, few features of the earth's surface are more deserving of study than the forest. Not only are forests widespread in their distribution, but they are a potent factor in the influence that they exert over the forces that constantly tend to modify the earth's surface, and they are also highly important as a basis of commerce.

Distribution and Character of Forests of the United States.

The study of forest distribution is of interest both locally and generally. Every student of geography should begin in this as in all other geographical studies, with the study of local conditions, broadening gradually to the general conception of forest distribution. A map of the immediate vicinity, showing the topography of the neighborhood, would be conspicuously incomplete unless it showed the distribution of timbered lands. Here comes in the opportunity to consider the relation of forests to farm lands, the influence of slopes, soils and moisture on tree distribution, and the nature of the forest growth of the vicinity

—whether hardwoods or coniferous, virgin or second growth, native or planted.

Taking then the broader view, the student of geography should learn where are the principal forest areas of the United States, and the general character of the forests in each region. For example, he should know that the principal hardwood forests of the United States are found in the Southern Appalachians; that the forests of New England are the chief source of the spruce wood so much used for pulp wood in paper manufacture; that the chief source of pine lumber so much in demand for building purposes, formerly in the region surrounding the Great Lakes, is now shifting to the pineries of the Southern States and to the coniferous forests of the Pacific Northwest. Of course every common school pupil will know that California is the home of the "Big Trees" but he should learn also of the important redwood forests of the Pacific Coast, which furnish a very considerable portion of the lumber used in the West.

Then there are the great plains of the Middle West, whose lack of trees gives a splendid chance to bring out the influences of climatic conditions upon plant life. It should be observed, too, that upon these plains the course of a stream is often evident for miles because of the fringe of trees which line its banks.

As an exercise in map drawing, all these data can be graphically represented very easily by depicting the various areas on a map of the United States by means of colored pencils or chalk. The Forest Service publishes a small map of this character, showing in colors the forest region of North America. Teachers of geography will find it a very desirable aid in their work.

The National Forests and National Parks.

Other features of interest to the student of geography to-day are the National Forests and National Parks maintained by the government. Most students will know about the national parks at Yosemite and Yellowstone, but will not, perhaps, know that there are other parks set aside by the national government. It will, of course, be impossible to locate the National Forests exactly, because there are too many and their boundaries are too irregular, but a glance at a map which shows their locations will instantly impress one with the fact that they are nearly all in the Western States and that they form two quite distinct chains following pretty closely the ranges of the Rockies and the Sierra

Nevada Mountains. The reasons for this furnish, in themselves, the text for a lesson in geography. The student may be led to see that the National Forests have been established in that part of the country which contained the chief forest areas of the country which have not yet been cut over; because this land, at the time the National Forests began to be established, was still a part of the public domain, hence could be set aside by the national government for any purpose desired; and because the land on which the forests are located should be, and is, chiefly mountainous land unsuited to cultivation.

The Influence of Forests upon Typography.

But geography includes more than merely a study of the topography of the country; it takes into consideration the manner in which its topographic features are formed and modified. In the influence they exert over conditions of climate, soil and water, forests are quite worthy of attention. Here the student of physical geography finds his field of research.

The question of whether or not forests exert any appreciable influence over climatic conditions is one much mooted in scientific circles. The student may experiment for himself along this line by recording and comparing at frequent intervals the temperatures registered on thermometers hung in the forest and others in the open. Scarcely anyone will dispute the value of forests as wind-breaks. The numerous shelter belts of trees planted about the farm buildings in the treeless districts of the Middle West furnish an object lesson of undoubted force on this subject.

Forests should also be considered in the influence they exert upon the soil. They have a twofold importance in this respect—as soil formers and improvers, and as soil protectors or fixers. It cannot but become apparent to anyone who visits the interior of a forest and observes the litter of leaves, fallen twigs and decaying wood which covers the forest floor, that trees contribute very materially toward the formation of the humus which makes forest land so fertile. Not only do the trees build up and enrich the soil, but they are instrumental also in preventing erosion. On steep hillsides light vegetable soil would be very quickly washed away were it not for the fact that the roots of the trees hold it in their firm grasp and the trunks, roots, and fallen branches place mechanical obstructions in the way of the down rushing surface waters. An interesting use of trees is that to which they are sometimes put in sandy regions—that of holding

in check and reclaiming drifting sands of areas such as the shores of the ocean or lakes, and the banks of streams. By means of tree planting, large tracts of what were previously waste sand areas have been reclaimed along the Columbia River and along the shores of the Great Lakes and the Atlantic Ocean.

Though not so evident to the eye, the effect of forests over the water supply of the country is also worthy of consideration by the student of geography. While it cannot be said that forests appreciably increase precipitation, it is nevertheless fairly well settled that they do control, to a greater or less degree, the run-off of surface waters. The spongy, easily penetrable litter of the forest floor soaks up the rain water much more readily than would barren soil, and the lower strata, being pierced by the roots of the trees, are also rendered more penetrable to the seepage water, hence the consequent effect can scarcely fail to be that less of the precipitated moisture will flow off as surface water and more will find its way into the soil to come out gradually through wells and springs. The ultimate results are the lifting of the water table in the ground, the regulation of the flow of streams and springs, and the decreased violence of floods after heavy rains.

Relation of Forests to Commerce.

All of the foregoing topics treat of the relation of forests "to the earth's surface." They will appeal especially to students of physical geography. But we have yet to consider the relation between forests and the "inhabitants of the earth's surface." To the teacher of commercial geography the forest furnishes material for extended study. First of all, the commercial products of the forest are numerous and varied. The lumbering industry, for example, ranks fourth in importance among the great industries of the United States. The story of the log from the forest to the lumber yard is full of interest, including, as it does, glimpses into the lives of loggers, river men, mill men and lumber merchants. Then there are the minor products of the forest to be considered—how the so-called "naval stores" are obtained from the great forests of Southern pines; how paper is manufactured from the spruce and hemlock forests of the Northeast; how the "sugar bushes" of New England and Ohio contribute the much-sought-for maple sirup and sugar to the commercial world. Then there are thousands of less important articles of commerce obtained from the forest; such, for ex-

ample, as nuts, medicinal extracts, gums, oils, etc. All of these products of the forest are obtained only by the labor of man, and thus in the course of their production and manufacture give employment to thousands of people. It is estimated that industries based wholly or chiefly upon the forest furnish a means of livelihood to more than one and one half millions of people in the United States alone.

Commerce, furthermore, is dependent upon transportation. The forests have a direct bearing upon the problems of transportation, and this must not be lost sight of by the student of geography. The earliest settlers in the United States found in the forests which hemmed in the Atlantic Coast a very formidable obstacle to travel and transportation. Nowadays, however. the reverse is true, for instead of being an obstacle, the forests are a great aid in facilitating transportation in at least two ways. First, they contribute much of the material necessary to construct our railroads and bridges—for even the genius of the Yankee inventor has not succeeded in producing a satisfactory substitute for the wooden cross-tie; and second, in the influence they have in regulating the flow of navigable streams, the forests tend to make transportation by water more practicable.

The Lesson of Conservation.

Finally, the great lesson which should be brought home to the pupil is the bearing of practical forestry on all these studies. What does forestry mean? Will it, in any way, help to make men "healthy and wealthy and wise"? The student of geography should learn that the chief aim of the forester is, not as has been sometimes charged, to place an absolute ban upon the cutting of trees, and thus lock up under government protection one of the principal resources of the nation; but rather to guide the people, whether owners of 5-acre woodlots or lumber kings with holdings equal to princes' realms, to a knowledge of how to use the forest, yet at the same time to promote its future development—for this can be done, without a shadow of a doubt. "Forest conservation" is the term which expresses this theory of the forester—not forest *preservation,* however, for forests are given us to use, not merely to look at, however beautiful they may be. Only, we must learn to use them prudently, and to eliminate all wanton waste.

Indirectly, of course, the lesson of forest conservation as taught by the forester will have its influence upon all conserva-

tion movements which seek, for the good of the people generally, to promote the unhampered but economical use of all our natural resources—minerals, water, soil and all the other gifts of nature to mankind. Thus, if the teacher of geography has a broad vision and an intelligent grasp of the subject, the pupils may be led, through the element of forestry in geography, to get an insight into what is now one of the greatest questions that confront our statesmen and economists—how to handle our natural resources.

AN ALKALI WATER FROM THE BLACK HILLS.

By Nicholas Knight,
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A specimen of water from a well thirty feet deep, near the Black Hills, in Butte County, South Dakota, was sent to us a few weeks ago for analysis. It was strongly alkaline, the sodium and potassium carbonates comprising three fourths of the total solid residue. A striking peculiarity of the water was its deep brown color. Boiling did not affect this in any way, nor did it come down in any of the precipitates, and it could not be filtered off. When the water was distilled most of the color remained behind in the flask, but even the distillate was tinged with brown. We are indebted to Mr. Ralph Ege of the Cornell chemical department for making the analysis.

The results of the analysis are as follows. The numbers express the amounts of the various constituents in 100,000 parts of the water:

Total solid residue	81.84
Silica	3.06
Iron and alumina	0.38
Carbon	3.14
Calcium carbonate	3.91
Calcium sulphate	0.65
Magnesium carbonate	10.48
Sodium carbonate	36.94
Potassium carbonate	23.17

The carbon found in the water probably accounts in a measure at least for the brown coloration, and it is doubtless a peaty water.

PUPIL EFFICIENCY.[1]

By Dr. Wm. A. Evans,
Chicago.

So long as teachers are willing to suffer the difficulties that arise from trying to teach children in rooms that are badly ventilated; so long as it is not the problem of the teacher, it isn't going to be solved. And one of the reasons why you—and I am now speaking to you people who are sitting in this room—so long as you are willing to allow the janitor the sole control of the ventilation in your school building and say that it is not your problem, it is not going to be solved.

I am not going to limit what I have to say to school ventilation; and yet, as being the largest factor in pupil efficiency, I am going to talk more about that than anything else. You have been talking here a day or two since your session began, about how to teach students, about the books that should be employed and the methods in imparting information from those books. A pupil that has been taught is the result of three factors; one of those is the teacher, the other the pupil, and the third the thing that is being taught. You cannot comprehensively consider or solve this problem until you take into account each of these three factors, and my plea here is that you pay attention to two of them, and ventilation is the other two. It is the other two because it determines in great measure the efficiency of the teacher, and it determines in great measure the capacity for learning on the part of the pupil, therefore it is two thirds of this equation, and probably that is where the mathematics teachers get in.

About 30,000 people die in Chicago each year, and of these about 10,000 die as the result of bad air diseases. The death rate from bad air diseases and from children's diseases constitutes two thirds of the total death rate in this city, and that is true of all parts of this country. It is about as true of the country as it is of the city, and about as true of other cities as it is of the city of Chicago. From that standpoint bad ventilation is worthy of our attention.

Probably, however, it is of more consequence from another standpoint. We are talking much of saving waste in this country; we are talking much of efficiency in this country. The best brains of this land are employed in working out machinery in which the

[1]Read at evening general session of the Central Association of Science and Mathematics Teachers, Lewis Institute, Chicago, Dec. 1, 1911.

element of waste will be reduced to the minimum; they are working out economic systems and plans of organization, plans of transportation and plans of commercial development in which the gain comes not from new fields of development so much as from an elimination of waste in the old fields. We have great brains planning machines, with the result that those machines are doing work more economically and less wastefully than work has ever been done before. Moreover, men are coming to consider the efficiency of human effort, through finding that the largest factor in that efficiency or inefficiency is bad ventilation or good ventilation, as the case may be. Of course we understand that good food is necessary and that you can't get a day's work out of a man whose body is being fed with fuel in the shape of food that is not nutritious. That is pretty well understood and it is of great consequence. We understood that food must be put in solution, and therefore it is necessary that the water used for that solution should be pure water, else the human machine will not work as well as it should. And so communities are spending many millions of dollars—this community sixty million dollars—for good water, to the end that there should be an increase in efficiency. The death rate from the diseases that are due to bad water is so small that it does not constitute a legitimate reason for the expenditure of money enough to get a good water supply.

Very much more important from the standpoint of efficiency than is good food or good water is good air, and it is from this standpoint that there is greater need for a comprehensive study of ventilation than there has been in times past. This phase of the subject far overshadows the other small matter of 10,000 deaths a year.

It is necessary that there should be an improvement in the general air supply. The human beings that make up a population of two millions are doing much toward the pollution of the jumbled mass of air. The fires that are burning here for the running of machinery necessary for the life of a great city, are doing much for the pollution of the air.

Perhaps some of you can remember when you were willing to drink water that was not altogether clear. Now we refuse point blank to drink water that does not sparkle, that isn't good and healthy. It is very important and it is wise that you should do that; but it is infinitely wiser that you should refuse to breathe air that isn't clean. However, at the present time if you refuse to breathe that kind of air you will shut off your total air supply.

And so we have got to have a movement representing millions of dollars and much of energy, to secure a purification of the air supply. This is going to take all of the soldiers that it can get; it is going to take every bit of backing that can be had. It is a movement in which the teachers must enlist. No teacher is fair to his community or fair to himself who does not enlist in that war.

But the general air may be good or bad without largely influencing the character of air that is to be found within the buildings; and bad ventilation, bad air within the houses constitutes the broad problem that I want to talk to you about to-night.

A large part of the children in schools are being harmed by the air that they are compelled to breathe. We have compulsory education. I doubt very much whether we have a moral right, if we have a legal right, to force a child to spend several hours of the day in a place that is going to harm that child, in many instances will harm the child more than the child will be benefited by that experience. It has been held that a community has no right to send a man convicted of a crime to a penitentiary where he may be brought in contact with hazards that are unduly great. Hence the community has not the right to put him into a prison and there subject him to undue hazards of life, such as would prevail in a prison that was the seat of smallpox, cholera, plague, or some infection of that character.

The question is, Has the community a right, through compulsory education, to take children who might otherwise be playing in air that was good or bathing in sunshine that was curative, and hold them for hours in a poorly-ventilated schoolroom?

Schoolrooms are generally heated by a central heating plant. The air is taken in from out of doors at a temperature of, let us say 10 or 15 degrees above zero, on a cold day, and 90 per cent saturated with moisture, as it is outside and at that temperature. It is run into a heating apparatus and heat is added until the temperature has come up to 80. Unless moisture is added to that air, step by step with the addition of heat, that air is made harmful, and distinctly harmful. It is harmful because it is unduly thirsty; it must have water. You cannot add heat to air without either adding moisture to that air or adding thirst to that air. Your humidity, therefore, has dropped from a relative humidity of 90 down to a relative humidity of 10 or 15. The air is pumped into the room, say with a 10 per cent humidity, and that means it is going to have moisture; it is compelled to have it. It will pick it up out of the chairs, and presently your chairs begin to get

rickety and fall to pieces; then the desks get rickety and fall to pieces; then the walls, then the floors or doors presently have shrunk and don't fit tight. If your air is getting moist from these sources, these places where there is but little moisture, you can be certain that it is taking a harmful amount of moisture out of those things in the room that are devised for the purposes of evaporation. There are no things in these rooms devised for the purpose of evaporation except the people that occupy those rooms, and they are God-planned for just that purpose. They are covered by skin that is constructed on a basis of evaporation; they have lungs that are lined with delicate epithelium and upper respiratory tracts, likewise lined; and one of the reasons for the delicacy of that epithelium is that there may be loss of moisture through those delicate membranes. If the atmosphere had a normal appetite it would be perfectly proper and perfectly healthy. We would be perfectly satisfied if that air had 30 per cent of thirst; that would be physiological, that would be normal and healthy. People should live in air that has about 30 per cent of thirst; that is to say, about 70 per cent of relative humidity is the point where there is greatest comfort and greatest well-being.

What we are complaining of, then, is not the thirst but the fact that that 30 per cent of thirst has been converted into 90 per cent of thirst, so that the air as it comes into the room is like a catfish. You know there is not much to a catfish except mouth. Air because of thirst is going to have water and it is going to take it out of the skin; and that means that the children's skins are going to be unduly dried. It is going to dry out throats and the upper respiratory tracts causing the bacteria that are normally there to get beyond those membranes. They are going to get into the tissues, and that is where the abnormality lies. Hence those children are going to have more infection than they would otherwise have; more colds, more measles, more scarlet fever, more diphtheria. In addition to these there are going to be subinfections; that is to say, milder bacteria that get through the surface and get into the glands of the neck making enlarged tonsils or adenoids.

As the result of the tonsils and adenoids the children cannot longer breathe normally through the nose, and so you develop mouth-breathers, and as the result of that the face comes to have an unnatural expression. Thus a great train of things leading immediately into pupil inefficiency, and ultimately into an improper physical development comes out of the matter of having the air

in the room unduly dry. The next thing of importance is that the air is too warm; the air around your body is approximately of the same temperature as your body—not quite, but approximately. This air has been termed by Sedgwick of the Massachusetts Institute of Technology the "aërial envelope." If there is to be comfort and well-being it is necessary that the air should be moved out of that envelope. The air around your head is called the "air breathing zone." You are breathing air from the interior of your lungs constantly into that zone. The air that you take into your lungs is relatively pure; the air that you pour out contains a moderate amount of body waste. Now, then, the question whether it is to hang around your head or whether it is to get out of reach of your nose is going to be solved by the temperature of the air around you.

If the air around your head is over 72 to 75 degrees, the air that you breathe out hangs right around you, and you breathe it right in again, not diluted. You have heard much about this matter of diluting carbon dioxide until it is harmless. The air that has just been breathed out will be breathed back again, not diluted up to one to ten thousand, or ten to ten thousand, but about four per cent carbon dioxide. That means that you will be materially harmed by this pollution of the breathing zone.

In order that the breathing zone and Sedgwick's "aërial envelope" may be properly cleansed it is necessary that the temperature of the room should be below 70 degrees; about 68 degrees is the proper temperature for the room. When the temperature goes over 70 degrees, the air is befouled and the people suffer to the maximum degree from that befouling. But things are a good deal worse than that.

The latest work on ventilation was that of Leonard Hill, and he demonstrated that for proper ventilation there is an absolute necessity that the air of a room should move with sufficient force so that its movement can be felt.

Now, you all know that the schoolrooms that you have been teaching in are schoolrooms where an effort has been made to so slow down air currents so that they cannot be felt; and here comes Leonard Hill with a last word, and the best word on ventilation, who says that there is a necessity that the air in schoolrooms should move so actively that it can be felt, and we have been working entirely on the wrong principle.

There is a necessity that the air should not be uniform. The human body needs the stimulus that comes from air that is ununi-

form. We need to have the physical side whipped up from time to time by air that is cold enough to stimulate the body as it strikes it; and that means that an apparatus or device that strives to maintain the temperature of a room evenly at 70 degrees, all through the day, will do harm unless there is installed somewhere a means of correcting that uniformity. The means usually suggested is that when the pupils have gone out at recess or at their dinner hour the windows of the room shall be thrown open.

How does all of this make for efficiency? I dare say that all of you have noticed that the first hour after school begins in the morning, it is relatively easy to teach; that concentration on the part of the pupils is not a difficult matter; that you get 99 per cent of efficiency after the first edge is off. But in the second hour, and particularly in the third hour, that there is a decrease in this capacity for concentration; that it becomes increasingly difficult for the pupil to learn; that it becomes increasingly difficult for the teacher to teach. A large part of this comes from the fact that the pupils cannot maintain concentration through a prolonged period, though a considerable part of it is due to the fact that there is a sameness of temperature and a sameness of air movement, or a lack of air movement during these several hours. This lack of edge will be done away with, for your pupils by varying the temperature, by having an unevenness of air movement.

I was at the Illinois Federation of Women's Clubs meeting awhile ago, and one of the striking things that I noticed was that at intervals of less than one hour, all of the ladies were instructed to stand up and stir about a bit while the windows were being thrown open. I was at the National Association for the Prevention of Infant Mortality meeting just ten days ago, and there the same system was employed, and I believe it to be one of the wisest customs that I have seen, certainly that I have recently seen.

I believe you will be interested in knowing what you can do specifically with the buildings that you are now teaching in since probably the majority of you have got to continue to teach in just those buildings, in just those rooms.

In the first place you can see to it that the temperature standard of the rooms in which you teach is held at 70 degrees, or better at a little under 70 degrees, about 68 degrees; that the windows are thrown open several times during the day, and that your schoolrooms are blown out. It is not a difficult matter to install apparatus for the discharge of steam into the incoming air, and in

this way even with the present type of construction, it is possible to bring your schoolroom humidity from about 20 to 25, where it is now, up to 40 and 50. You should carry it to a point where the windows sweat, and in cold weather the windows frost.

With a proper type of construction, one that provides for heating the outside wall, you could bring the humidity up to 60 or 70 before the wall sweating becomes troublesome. If it is not possible to introduce wet steam into the incoming air, the best thing you can do is to provide various kinds of evaporating apparatus in your rooms—and there are many of these. Cans of water do fairly well; apparatus that hangs on the radiator does fairly well. With none of these will you succeed in bringing the humidity of your rooms over 40. Still it is a considerable and material improvement over the conditions that now prevail.

Another thing that could be done in a great many instances is to install fans in the room. Electric fans that stir up the air in the room will blow it around with enough force to clean the breathing zone, and that is easily done in the prevailing type of schoolroom.

Another very important thing is that every room should have one or more thermometers, and it should be a part of the duty of somebody occupying that schoolroom to make and record an hourly observation of the temperature; not at one place in that room, but taken at different places, at different heights above the floor, at different points along the wall so as to get a fair average of conditions that prevail on the inside walls as well as the outside walls. And another thing that you can readily do is to provide a second thermometer right by the side of the first; take one of these as a wet bulb thermometer, or else purchase a dry and wet bulb thermometer, or in other words, a hygrometer, and make use of that in your schoolrooms. I am sure that you would be surprised. I have probably a thousand letters from people in the Upper Mississippi valley who during this season for the first time have taken account of the humidity that has been prevailing in places where they were, and they were dumfounded to find the dryness of the air in which they have been working.

We know that the average school child is underfed, and particularly underfed in those food substances that make for nutrition. We know that the average school child is forced to breathe air that is polluted, and in this way the nourishment that it gets does not properly nourish. We know as the result of experiences that run into the hundreds of thousands that the disposition to

punish a child for its mental deficiencies and oftentimes for its soul defects does not spring from mental conditions, but is the result of physical defects, is the result of things that the child cannot control and is not in any way responsible for.

It is of importance from the standpoint of school economy. Mrs. Young tells us that repeaters are responsible for a waste of $275,000 a year in the city of Chicago; and educators of large experience say that 90 per cent of repeaters are such by reason of physical defects. It is of consequence from other standpoints. The child that is not feeling well, that has teeth that are aching, that cannot properly chew its food because of bad teeth, that does not rest well by reason of being a mouth-breather, that by reason of one of these or several of these combined, is not able to maintain itself in the schoolroom, loses interest in its studies, and presently begins to drop away; first, tardy and then staying away more or less uncertainly for a day, and then staying away more or less viciously for a day or more than a day. Presently the child before finishing its grades, and certainly before having gone into the high school, has dropped out of school. Then that child goes into trade, and thus it influences the price of labor and influences the price of commodities; and then that child goes into citizenship.

We have heard of the loss from bad school children; the loss from waste in school children. We have heard of the loss of labor from working immature school children, but they are nothing as compared with the blight of men and women who are exercising the franchise, who are influencing legislation, who are influencing judicial decisions, who are influencing public opinion, who are deciding what shall be done with children, who are deciding what shall be done with derelicts in society.

In the solution of these problems there are men and women that bring to them the highest of motives and the purest of souls; men that bring to them minds that are balanced and sane and trained. But in the solution of these problems there are other men and other women that bring to them the point of view of the people that have come up in the shadows and that speak from without the dark; and these voices of neglected men and women are determining these questions to the sorrow and to the waste of our land, in greater measure than they are being determined by the brighter minds and purer souls. Thus in far greater measure than in any other is bad ventilation and its blight being writ in the history of human affairs.

HOW TO MAKE BOTANY INTERESTING TO BOYS AND GIRLS REARED IN A CITY.

By A. F. Ewers,
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The child reared in the city has an environment which separates him almost completely from those influences which tend to develop the healthy, normal child of the small town or rural community. No regular home duties are his to perform; no assistance rendered father and mother in the daily tasks that maintain the home; no feeling of partnership and responsibility in the cares and labors that burden the family head. His life is filled with excitements. He is awakened in the morning by the newsboy crying out some sensational bit of news, and as he leaves school in the afternoon the "Extra Sporting Edition" is just off the press. On all sides he is surrounded by the artificial; man's work, wonderful, magnificent, and awe-inspiring, makes a deep impression on him, while God's work, stunted, distorted, and robbed of all its beauty, is but little noticed by him. Dwarfed trees, with trunks and branches covered with soot and grime, with leaves shaded by buildings, and with roots buried beneath brick pavements and cement walks, grouped together, form his mental picture of a majestic forest. A closely-cut lawn of a few square feet is the city child's real view with which he must build in imagination to see before him the broad sweep of meadow land. A narrow back yard surrounded by a high board fence with sheds and ash pit in the rear, with, perhaps, a lilac bush in one corner and a bed of geraniums in the center, forms, very often, the "deep tangled wildwood," which city-bred children in their "infancy knew." With no knowledge of the wonderful plant world, but with the belief, born of ignorance, that the dwarfed, mutilated, soot-begrimed vegetation seen along the city streets composes the great world of nature, the city pupil enters the class room to begin his work in the study of botany. A wise teacher once said that a man must be "born again" in order to realize the full benefit of his teaching, and to the successful botany teacher comes the problem of so adjusting his teaching that the child's conception of the world of plant life is "born again."

I believe that the work of the first month, at least, should consist of, what we may term, seeing lessons. These seeing lessons should begin with most familiar plants, and the child should have put before him, not a part of a plant, but the whole plant. The

work on these plants should be conducted more along the line of nature study work and no attempt made, as yet, to make it purely scientific. Every interesting thing concerning these plants that will tend to correct the child's warped notion regarding plant life should be brought out, comparisons between plants, work of different parts, advantages and disadvantages of different forms, together with a study of habits, history, and use. Make the range as wide as possible, and do not neglect to call attention to water plants, algæ and fungi. Encourage pupils to bring in specimens. Call the attention of the classes to specimens brought in and make every possible use of them. Get them started in the search of fungous plants and they will learn more about the whole vegetable world by seeing things with their own eyes than in any other way. Our pupils brought in a large quantity of fungous growths during the fall months, and some of them were so interested that they examined nearly all the trees in Tower Grove Park in search of specimens.

On the first Saturday, and every Saturday thereafter when the weather permits, the teacher should conduct field trips. There is nothing, in my estimation, that creates a greater and more abiding interest in the subject. There is nothing that aids so much in correcting the child's view of nature as a carefully conducted field trip. Some city teachers say that field trips are impossible, but this is a mistaken idea. The conveniences afforded by suburban lines for getting out into favorable regions, at little expense, are all that can be desired. Won't the children go? If not, something is wrong with the teacher. Nothing is more contagious than rightly conducted field trips. Pupils will change their hours for music lessons, will give up dancing lessons, will do their home work evenings, that they may have Saturday at their disposal. True, not all pupils can go, but such a large percentage will receive a benefit from these trips as to increase materially the interest of the whole class and raise the standard of the work. On our first Saturday trip last fall we had sixteen students with us. The pupils made a written list of the plants we found and noted their location and environment. During the week we talked about these plants, and the conditions under which they were growing. The next Saturday we more than doubled in numbers and all the pupils returned enthusiastic students. On these trips we had pupils who were taking their first ride on a railway train, pupils who had never seen a plow turning the soil or a field made ready for planting. Picture the pleasure and profit that these would

receive from a tramp through the big woods, examining the bark and leaves of trees, gathering the flowers of the lobelia and aster, making bouquets of the bitter-sweet and coral-berry, and attempting to satisfy a hunger more keenly felt than usual because of the exercise and fresh air by eating wild crabs, plums, and persimmons.

On these field trips material is collected and pictures are taken. The material is used in the class room and everything that can be found out about the specimens is talked over in class. The pictures are made into lantern slides and have far more interest for the pupils than those purchased. From these lantern slides a more detailed study of plant colonies and special features may be made and the same spot revisited with added interest and profit. I know that field trips are both possible and profitable, and believe them to be the greatest factor in creating a healthy, human interest in the subject of botany. Without them, the student labors through a course of class room botany and finishes thinking that plants exist that teachers may perform experiments.

In conducting laboratory work there are several methods of procedure. Some save the teacher time and trouble, while others take time and make trouble for the teacher but give to the pupil a live working interest in what he is doing. I have seen in well-equipped laboratories, fitted with all the apparatus necessary for individual work, the teacher doing the work while the pupils look on. This is an easy way, no noise in the room as but one person is working and he knows how to work quietly. But how about the interest of the pupils? Allow pupils to take the material and apparatus and do this work for themselves; watch the expression upon the faces of those who are doing something themselves and compare with the faces of those who are seeing it done for them, and you will decide that interest and some noise in a workroom is more advantageous to a pupil than less interest and less noise in a laboratory where the teacher is the star performer.

In one large high school, I found the teacher directing the work from the very beginning by the means of typewritten outlines. His pupils had just left the grade schools and this method of working from an outline in which they were directed to take strange material and with strange apparatus do certain strange things was as foreign to them as the subject was new. For instance, they read: "With a scalpel cut a soaked kernel of corn in two lengthwise through the groove. Examine the cut surface

and describe in your notebooks what you find." The pupils were doing the work in a mechanical manner with a bored expression upon their faces. In another high school, I found the teacher doing the same work with the same grade of pupils in a different way. Instead of sitting indifferently at his desk, he was standing near the center of the room. His face plainly manifested a lively interest in what the pupils were doing, and he was directing orally their work. When he gave the directions about the cutting of the grain and then said: "Examine the cut surface," you could gather by his tone that they would find something worthy of their search and every pupil was eager to be the first to find it. Hands began to spring up all around as bright eyes saw for the first time the parts contained within.

Every teacher knows that a very small number of his pupils will enter college, indeed, but a small percentage will finish the high school course. He has the right to assume that most of them will live their lives in the city and that many of them will own homes with small plats of ground which they may cultivate or neglect. Should the pupil who finishes a course in botany in a city high school, know better what to plant, how to plant, and when to plant, than his neighbor who left school when in the grades? Does it interest a high school pupil to know that he can hide ugly fences and ash pits with vines and shrubbery? That he can turn his bare back yard into a lovely retreat by the proper arrangement of spireas, lilacs, gooseberries, currants, viburnums, dogwoods, and sumachs? And what a splendid opportunity the city teacher has to make this work possible. In the parks and gardens are the various shrubs, and from these may be learned the peculiar characteristics of each, together with its fitness, value, and place, in a shrubbery mass. As our high school student and his neighbor, who did not finish the grades, now men, stroll through the parks together, ought not the first to know more about the trees, shrubbery, and flowers, found growing there, with something of their enemies and diseases, their habits, value, and care, than the latter?

A summary of what I believe will create an interest, in the subject of botany, in children reared in the city is as follows. Lead the students to an appreciation of plant life by making the beginning work more in the line of nature study. Emphasize and encourage field work. Make your personality count in conducting laboratory work. Bring into your course a knowledge of how to use plants to a practical end.

THE CORRELATION OF HIGH SCHOOL CHEMISTRY AND DAILY LIFE.[1]

By John C. Hessler,
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The topic of the symposium relates itself immediately, as I see it, with the important movement gathering head throughout our country to conserve, in ways and to an extent undreamed of by the fathers, the life, the effort, and the resources of our people. No phase of the conservation movement is more promising than the attacks being made upon the strongholds of drudgery. If man's activities be classified into play and work, then *drudgery is work gone to seed.* Its characteristic is performance without motive; hence it is monotonous, unrelated to creative work, and incapable of being performed with enthusiasm. We have yet to learn, as a people, that no one does us a greater service than he who finds a way of injecting into the thousand monotonous tasks that must be performed in the kitchen and the factory, and on the farm, the purpose and satisfaction of real work, coupled with some of the exhilaration of play.

Now, the modern educator, in studying the activities of the child, finds that drudgery is not confined to kitchen, farm, and factory. With an industrial system entailing so much monotonous labor for the adult, it is not surprising that the work of the school is found to be full of drudgery for the child. Here, again, we have a multitude of tasks performed, not with the interest inherent in play, nor with the purpose of significant labor, but rather with only one object; to meet the demand of the master—the teacher. No teacher can have failed to see, and to deplore, the character of work done on so low a plane, and with so arbitrary a standard. The teacher may not lightly recommend that the pupil drop a course in which he is not interested. The point to be noted is that the nature of the pupil requiring teaching, the equipment of the school *for* teaching, and the experience and training of the teacher constitute resources of our civilization, and they must be conserved if that civilization is to accomplish its purpose. Teacher, pupil, and school must remain together long enough to permit the transformation of the untrained child into the useful, thinking, self-governing citizen. To this end the teacher MUST find motives which will infuse into school work the

[1]Read before the chemistry section of the Central Association, Lewis Institute, Chicago, Dec. 1, 1911.

interest, the purpose, and the methods that obtain in work which the child considers worth the doing.

The need of motivation is not confined to the grade schools, nor to nonscientific subjects. Nowhere are motives more needed to give enthusiasm and purpose than in the laboratory sciences. When laboratory work was introduced into the high schools, the argument for its adoption was that it would stimulate the interest of the pupil, for the reason that he would be able to repeat the experiments of the great masters of science, and so have a practical basis for applying to daily life what must otherwise remain, for him, merely wonderful, unrelated facts. But an experience of some years in teaching chemical science convinces me that the attitude of the average pupil to science is in no way different from his attitude toward other studies. As with mathematics, language, and history, so with chemistry; the *average* pupil does not work with enthusiasm, as though compelled by self-interest, but mechanically, and in the least finished way which the teacher will accept. This, be it understood, applies to *all* schools, even to the universities. The task is done *essentially* to pass the criticism of the teacher, not to attain to a standard of excellence set up by the student himself. Because the stimulus is all from the teacher, the student does not think of articulating either text-book lesson or laboratory exercise with other knowledge. Least of all does he think of the school task as he would of similar work in the world outside. For him each lesson is an isolated exercise to be learned, each course a nightmare to be successfully "passed" and never heard of more. No wonder that we cannot get our pupil to remember his exercises from day to day, and that we find him entering each new course with a minimum of knowledge and experience from the one that preceded it.

What are the causes of the pupil's attitude toward the science studies, and particularly toward chemistry? At the risk of duplication and of omission I give the causes as four in number:

1. The idea that there is no vital connection between chemistry as taught and as applied in the activities of the home, the farm, the factory, and the community is borne in upon the pupil, not only by his own observation, but by the attitude of the school, the home, and the people at large.

2. The character of the topics studied, or *not* studied, in the high school course of chemistry. The most interesting things, from the point of view of curiosity, are left out.

3. The logical arrangement of the chemistry course makes it

a mechanism that is *"good"* for the pupil, but for which the pupil, as he is not in the secret, cannot see the reason.

4. The strict differentiation of chemical science from physical and biological science and the natural inference, on the part of the pupil, that it is also differentiated strictly from the science of common life.

The operation of the first cause—remoteness of the work done in the laboratory from that done in real living—may be looked at from several angles. One observation is that the laboratory apparatus is totally *different in form* from the apparatus with which the child is familiar. Again and again have I noted that girls specializing in domestic science, who were using the gas stove daily, failed to recognize it as a Bunsen burner. This is probably an extreme case, but it illustrates well the lack of correlation in the mind of the student while he is performing his laboratory work. The remedy here, it seems to me, is to call attention, by actual demonstration of the commercial and household forms of our laboratory equivalents, to the relation between the two. The teacher makes a mistake if he sends the pupil to the business men dealing in the commercial forms of apparatus. Even if these merchants understand fundamental principles, and they rarely do, they either cover their knowledge with technical jargon, or refuse to take the questions of the pupil seriously.

To take another illustration: Our chemistry courses give the properties and reactions of water, but they do not go into sufficient details regarding water in the house. We cannot assume that the pupil knows the details of a water or plumbing system, neither can we tell him to go to his home to find out. Most pupils, especially girls, to say nothing of the parents of pupils, are afraid to dissect apparatus in actual use because they are not certain they can replace the parts correctly. Will it detract seriously from the value of the study of water if the teacher shows, by actual dissection, the construction and use of meter, filter, faucet, trap, heater and tank, and the methods used to secure water-tightness in the system? We hurry over such topics too rapidly, taking things for granted, forgetting that some, at least, of our pupils do not have access to all these modern improvements, or, if they do, they see only the exterior, and have no conception of the way in which the mechanism works.

As the second cause of "severed relations" between chemistry and common life I have placed the character of the subjects studied, or NOT studied, in our modern chemical courses. The earlier

lecture course method of chemical teaching was full of showy experiments, in which changes of color, sudden explosions, and noxious odors played leading roles. The student who was permitted to work in the laboratory repeated these experiments, or devised new ones of the same pyrotechnic sort. The result was no end of interest, but little real insight into the methods of the science. What impresses one who knew the earlier method is the list of substances *not* prepared in the modern course. Exigencies of large classes, and, more important, danger to life, limb, and eye, have driven out of the course practically all experiments with, and preparation of unstable compounds. A science that was once all life and energy has become respectable, safe, and prosaic. I am not contending that *our* selection of topics is not better than the old one, but I do assert that it has not equally strong motives of interest for the pupil. Can we find motives that will furnish as real a stimulus for the determination of the equivalent weights of magnesium and hydrogen, for the weight of a liter of oxygen, and for the study of solutions, as for the preparation of nitrogen iodide, chlorine dioxide, and nitroglycerine? I believe we can, but it goes without saying that we must appeal to a deeper interest. For one thing, we need to restore some of the rejected topics of the earlier science. To illustrate: The average pupil in chemistry knows nothing about an electric battery, even if he has studied physics. His supply of current came out of wall, floor, or ceiling. He knows nothing of electric charges, because the study of frictional electricity has been cast aside. Even the most fundamental physical phenomena are nothing to him. A recent text-book uses the abnormal osmotic pressures of aqueous salt solutions as evidence of dissociation in solution, but nowhere defines or describes osmotic pressure.

It is vain for the chemistry teacher to say that problems of sanitation belong to household science and those of osmotic pressure to physics. Pupils studying chemistry may not have taken domestic science and physics, or if they have studied these subjects, may not have understood them owing to lack of knowledge of the chemical principles involved. We must remember that the average pupil, in spite of the advanced mechanical and commercial age into which he is born, takes about as long for his development as his grandfather before him, and he cannot overleap all the intermediate stages of scientific thought without being hopelessly stranded.

My third cause was the *logical system* according to which

chemistry is presented. No one would insist more than I upon a rationally consecutive order of topics for the formal course in chemistry. But it does not follow, after a general plan has been adopted by the teacher, that all the pupils need exactly the same chemical pabulum from day to day. Most have preferences, and we do our work with best results when these preferences receive some consideration. The logical order is not the order in which we become acquainted with common substances. Milk, butter, flour, meat, wood, stone, porcelain, cloth, these are much more natural to us than hydrogen and chlorine. Even natural water and air are very complex. We begin chemistry, and I believe correctly, with the study of gases, but the gaseous condition is not readily comprehended. Hence, when we present to the pupil hydrogen and oxygen, while we are really choosing the simplest forms of matter, we appear to be taking those farthest removed from common experience. The remedy is to prepare not two, but *many* gases, and to show their resemblances and their easily demonstrated differences, so that the pupil can get a more definite conception of what we mean by a gaseous substance.

But I believe a more radical departure still must be made from the strictly logical order to bring chemistry "back to the people." To return again to the topic of "water," there are few regions in which there are not several sources of the supply. The tests for chlorides, nitrites, sulphates, organic matter, and hardness are easily made. By means of miniature water surveys these tests can be applied for months, instead of once or twice, and the content of the water samples correlated with weather, rain supply, etc. Milk surveys, butter surveys, studies of the salt, sugar, vinegar, coffee supplies, of patent medicines, etc., will give zest to the formal study of our science, and will relate it to our community life. *Ultimately,* the permanence and the value of any activity must be measured by the community standard.

Such a synthesis of knowledge would remove the cause I have placed *fourth;* namely, the differentiation of the sciences from one another. This differentiation, no matter how desirable it may have been in the past, nor how necessary it may still seem to the investigator, has gone too far to be of benefit to the pupil in the secondary school. This worship of differentiation was well expressed by one of its devotees when he stated, in response to the question as to whether general science was desirable for the first year of the high school, "I do not want the student taught general science because I wish him to know what science he is study-

ing." As I see it, it is important for us to enrich *any* science by bringing into it the discoveries and conclusions of the others. Biology teachers are wont to deplore the inadequate conceptions which their pupils, not to speak of the general public, get of organic evolution. I commend the "Electromotive Series of the Metals" to them as an illustration of evolution based upon environment. The texts usually state that in this series the metals that precede replace those that follow, in the solutions of their salts. This is an interesting, but isolated, chemical fact. The series is a great deal more interesting to the student if it is made to reveal other chemical facts. Thus, the stability of the oxides *decreases* as we proceed, so that only mercury, and those that succeed it, can be obtained by heating the oxides, hence only these metals will not rust under natural conditions. Still more illuminating is the observation that the metals group themselves on each side of hydrogen, and that the metals that were to be used in the simple voltaic cell were definitely conditioned by their positions in the series. But the greatest interest of all is aroused when we ask what metals were likely to be discovered *first* by man, and what the order of the discovery of the other metals would be. This picture of the evolution of industrial civilization is of sufficient interest to even average pupils to require no further motivating.

To summarize, then; to motive high school work in chemistry I would first purposely bring in commercial and domestic apparatus and show its working in detail, even if I had to sacrifice a little of some of the commonly accepted topics, and, in the second place, I would, early in the course, myself contribute, and ask the students to contribute, to a list of topics of a chemical nature capable of investigation in the community served by the school. I would assign these topics, as far as possible according to preference of the student, for work during the whole year, or as much of it as seemed desirable, for work of an investigative character. Moreover, if I had to choose, I would give the most interesting and productive topics to those students for whom the subject required the most motivating. Such work would do service of another kind not contemplated at first, viz.; it would motive the work of the teacher himself and relate his own work with that of all the other significant factors that make for a more sane and fruitful community life.

THE PERRY IDEA IN THE MATHEMATICAL CURRICULUM.

By Jos. V. Collins,
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At one of the first meetings of the Central Association held at Armour Institute seven or eight years ago Professor John Perry's ideas concerning the teaching of mathematics were presented by several speakers and were received with enthusiasm. So far, however, very little has been done in America towards turning the attention of the teachers of secondary mathematics generally to Perry's reform; nor, so far as the writer knows, has much been done in the way of changing courses to conform to Perry's ideas even in our most advanced schools.

Now, two strong reasons exist why adopting the Perry idea of teaching the simplified elements of higher mathematics in secondary schools should be carried out. The first is that a spiral course in mathematics in which the spiral idea is not overdone is coming more and more to be recognized as far preferable to the strict topical plan heretofore followed throughout the curriculum. The second reason is that the American high school or academy of to-day must meet far different conditions in the life of its graduates than the same school did twenty or even ten years ago. The American high school is becoming the people's college, and, as such, must broaden out in the sweep of its training, and specialize more and more in particular subjects.

Taking up the discussion of the latter question first; *viz.*, that of bringing college mathematics down into the high schools to benefit certain classes of students who desire to specialize in mathematics or in subjects which demand much mathematics, it can be said that the existence of night schools, correspondence schools, and university extension work which gives courses in advanced studies of all kinds shows a wide demand for preparation of this kind. How much more intelligently such work could be carried on if the student had had the advantage of some training in the elements of the higher mathematics while still in the high school under the direct supervision of trained teachers. Also how much more likely the correspondence student would be to succeed if he had had a good grounding in the fundamental principles of the higher mathematics.

Without trigonometry the worker is almost helpless when it comes to the solution of a great number of problems which occur in anything partaking of the nature of engineering or construc-

tion. With the simplest elements of trigonometry, analytics, and calculus in his equipment, the worker is prepared to solve almost any ordinary problem that is likely to turn up. Or if he is not able to solve it, he knows where to place it and what he must learn to solve it, in case it is soluble.

It seems a vast pity to have the pupil spend ten years of his life learning arithmetic, algebra, and geometry, and then to draw a hard and fast arbitrary line, and say to the pupil, thus far shall you go, but no farther, unless you go to college and take the full mathematics course. For educators to do this at the present time seems to be taking an untenable position. One has a right to believe that it will be such in the long run.

But perhaps someone is saying that trigonometry, analytic geometry, and the calculus cannot be taught to persons of high school maturity of mind even though they may have specialized in mathematics. To such one can reply that logarithms are being taught everywhere to high school pupils, and there is nothing in the solution of right triangles by natural functions nearly so hard or abstract as portions of the study of logarithms. Very possibly it may not be known to teachers generally that all cases in oblique triangles can be solved by right triangles, as Olney in his trigonometry shows, or as anyone may convince himself by a few minutes' examination. It is not necessary to teach what is called goniometry at all, aside from explaining the simplest ideas as to what an angle is, to teach the solution of any triangle whether right or oblique. Of course for college mathematics goniometry is essential. But virtually any and every practical problem likely to occur at all depends on the solution of a triangle.

Then, as regards analytics, we know that the analytical treatment of the straight line and circle and perhaps a little of the other curves is a comparatively slight extension over what the pupil knows already from his study of graphs in algebra.

But the best reason to urge to satisfy the critic that not only trigonometry and analytics, but also the calculus can be taught to persons of secondary education maturity consists in quoting the authority of Perry and of Professor Klein of Goettingen, and of many other eminent teachers who have tested the matter for themselves and found out that the teaching of these subjects is feasible. Professor Perry has taken the trouble to show exactly how the ideas of the calculus can be presented most simply. How then dare the secondary teacher set up his judgment against these authorities on a matter shown above to be so important?

It might be added that some of our ablest mathematicians have done world famous work while still not much beyond the high school age. Why then should not the boy specializing in mathematics not be allowed to know something of the simplest elements of higher mathematics? Certainly the beginning of the calculus for a senior in the high school would not be found as hard or confusing as the theory of limits in the second book of geometry for a second year student.

The first reason for teaching the elements of higher mathematics in the secondary school stated at the beginning of this article, *viz.*, that this plan introduces a very desirable moderate spiral into our mathematics curriculum has no doubt been in the minds of those who have been urging this innovation as well as the other reason, or the desirability of giving this mathematics to those who will probably never be able to go beyond this point of mathematical culture in their studies.

Nothing can be much clearer than that a student taking up a new branch can study it far more intelligently if he knows something of the scope and purpose of the study before he begins it. Every secondary teacher knows that very many pupils fail to get hold properly of demonstrative geometry because the subject is so different from anything they have had. Since they do not know what it really is, they do not know how to study it aright. The same thing is true of pupils in elementary algebra, though the teacher does not usually realize the existence of the pupil's troubles so clearly. If the pupil has had even a very brief course in demonstrative geometry before studying algebra, his chances of success in both algebra and geometry are greatly enhanced. In the same way teaching the simple elements of college mathematics in the secondary school prepares the student for very much more intelligent and effective study of these branches later on.

But possibly some college professor will rise to say he does not want his students taught trigonometry, analytics, or the calculus, especially the latter, since the pupil is in danger of getting erroneous ideas, which he would not have got if the professor only had taught him his higher mathematics and had taught him right. The answer to this is that the professor might just as well object to the pupil's knowing anything about arithmetic, algebra, and geometry for fear he might have got some erroneous notions, the chances being if he has them in calculus he has them in algebra also. There may possibly be some point to the con-

tention about the calculus, since the college professors differ among themselves, and professors in different countries disagree on this matter. If, however, the elements of the calculus are correctly presented by the text used, the pupil will likely get it as near right as he can, and if they are incorrectly presented by a college book, the college student will get the matter superficially. The chances are that a secondary teacher would follow his text in an advanced subject.

One matter in connection with this subject has not been discussed. Recently when the writer was arguing along the foregoing lines at a teachers' association, he found after the meeting that his ideas were not very popular in certain quarters, *viz.*, among those secondary teachers who had never studied trigonometry, analytics, and calculus! Evidently there is but one answer to this objection, and that is that such teachers should either get busy and take these subjects in summer schools, or else surrender their jobs.

America has the opportunity to-day to take advanced ground in mathematical instruction in both the secondary school and college. We need first of all to break down the watertight compartment idea of mathematics being made up of a number of isolated and unrelated subjects. We need to give a practical turn to all the branches as far as we can, vitalizing algebra with practical formulas from the other branches and from science, and geometry and trigonometry with a much greater variety of practical applications. We need to carry the study of graphs into at least a little of its fruitage in analytic geometry, and we need to show that the elements of the calculus can be as easily comprehended as any other of the fundamental principles of mathematics. We need to unify more fully all our mathematics from arithmetic to the calculus. We need to raise the standard of attainment in mathematics in both our colleges and secondary schools, and all this can be done and done easily if we go about the matter in the right spirit and in the right way.

AMERICAN COMMISSIONERS ON MATHEMATICS.

The United States Bureau of Education has recently issued Bulletins Numbers 13 and 16 for 1911, the former containing the Report of the American Committees I and II, on Mathematics in the Elementary Schools of the United States, and the latter containing the Report of the American Committees III and IV, on Mathematics in the Public and Private Secondary Schools. These Reports are prepared under the direction of the American Commissioners of the International Commission on the Teaching of Mathematics. They may be secured gratis by addressing the United States Commissioner of Education at Washington.

J'ACCUSE: GEOMETRY TEACHERS.

By A. Latham Baker, Ph.D.,
Manual Training High School, Brooklyn, N. Y.

In the historic words of a famous French writer

J'accuse:

geometry teachers in general of neglecting a very important feature of their pedagogy. Its essentiality is so striking, its use so pedagogically luminous that its omission is a most surprising feature of educational history.

Says Ufer in his *Pedagogy of Herbart*, "The pupil must know from the beginning what is aimed at, if he is to employ his whole energy in the effort of learning." The teaching of geometry in the text-books, and naturally as a consequence thereof, in the class rooms, utterly neglects this aspect of the subject, to the shame of the pedagogy and the loss of the student. Geometry in the schools has been merely a drill in certain type forms, with guesswork applications of the types to original problems. From the beginning of the subject, and throughout, the student is told to make (or suppose made) certain constructions without a hint as to the object, purpose, or end of such construction; and the purpose is never told. As a recent contributor to School Science and Mathematics has said, the demonstrations seem purposely to keep the student in the dark until the "trap is sprung."

The fact that the construction opens up a flood of consequences is apparently deemed sufficient, and neither student nor teacher seems to realize any mathematical predetermined reason for any particular construction, and the student is left to wonder what in the world first suggested such a procedure.

No student should ever be allowed to make a construction line in his demonstration diagram without first giving a predetermined reason telling what Figure *he expects to secure thereby, what* Use *he expects to make of that figure, and with what* Theorem *he expects to utilize that figure.*

This and this only will satisfy the requirement of Ufer.

For example, in the theorem, If the sides of a quadrilateral are equal the figure is a parallelogram, the student, under the direction of the book, draws the diagonal. Why? He does not know, and is never told.

He should be required to give his reasons, and should be instructed how to decide upon those reasons, namely, to get a pair of triangles, to prove two sides of the original figure equal

by means of the triangle theorems; or perhaps to get a transversal cutting two lines, in order to test their parallelism by means of the parallel theorems; his choice depending of course upon his definition of a parallelogram, opposite sides equal, or opposite sides parallel. With this clear purpose in view, he sets his own "trap" to suit himself and anticipates the springing.

It is a crying shame that this all-important and most luciferous aspect of the subject should be so utterly neglected. I recently had the pleasure of reviewing an elementary geometry, written under the joint authorship of several very able and eminent teachers. One of the features of the book was the giving of a reason for every step. And yet as a reason for drawing the line AB in many diagrams was given the straight line postulate, a straight line can be drawn between any two points, utterly oblivious that this was no reason at all for the special position of that particular line, but merely an assertion of its possibility. This illustrates how the pedagogic aspect to which I refer has been almost entirely neglected by the teaching body. One would think that the mere suggestion of such an aspect would be seized with avidity, as giving the student a grasp and power that no amount of parrot drill in types could possibly do. To be sure, the student must be taught how to make his choice of construction and how to decide upon his reasons. This cannot be done at haphazard, but must be systematically based upon a proper foundation.

The corner stone of the foundation is the *dominant operation*: comparison of *lines, angles, surfaces,* for equality, inequality or measurement; the operation which dominates and determines the construction.

Having decided upon this, the student is prepared to take the next step, selection of the figure and theorem with which to accomplish this comparison. If he has these classified (see SCHOOL SCIENCE AND MATHEMATICS, 1910, Vol. 10, p. 393) this will not be a difficult step. This step once made, the predetermined reason for the construction is settled.

For example, in the case cited above, if he decides that his dominant operation is comparison of lines, because his definition of a parallelogram is a quadrilateral with its opposite *sides* equal, and then decides that he is going to try to compare these unknown sides by means of the triangle theorems, his construction is settled and his reasons evident.

If he defines parallelogram as a quadrilateral with its opposite sides parallel, then his dominant operation is the measure of a zero angle (parallelism) and if he selects the parallel theorems as the tool to do this with, the object and purpose of his construction is apparent, and he draws the same diagonal solely for the purpose of getting a transversal.

This systematic and selective determination of dominant operation and the tool must be secured by the orderly list of the operations (see list above) and tools (see SCHOOL SCIENCE AND MATHEMATICS, *loc. cit.*). Coincidence axiom, sum-angle theorems, broken-angle theorems, vertical-angle theorems, broken-line theorem, etc., with a thorough understanding of the *uses* of these theorems for the purpose of comparison, etc. (see SCHOOL SCIENCE AND MATHEMATICS, *loc. cit.*).

The student must be taught how to use this systematic list by means of the **3 W's** (after selecting the dominant operation):

WHAT FIGURE is expected to be secured by the construction?

WHAT USE is to be made of the figure?

WHAT THEOREM is to secure this use?

These questions should be asked at the beginning of each theorem. If the student has a satisfactory answer for these three questions, he has practically secured the demonstration (with exceptional cases), and secured it with a grip that no amount of wooden memorization of type forms could possibly give. He will have set his own "trap."

With this method he would attack a new problem much as he does one in algebra—what processes shall I use, not where have I seen this problem or its like before? But of course the **3 W's** must be supplemented by the consequences which flow from this selective and predetermined construction. In the example above, when the student has drawn his diagonal for the purpose of getting triangles (say) with which, etc., he finds that his triangles are useless, because not enough parts are designated to enable him to draw any conclusion. Here he must take use of the **3 F's:**

What **FIGURE** have we before us?

What **FACTS** (theorems) do we know about such figures?

What **FOLLOWS** in this particular diagram?

In the case cited, he finds that in addition to triangles which he constructed purposely but vainly, he also has parallels **(FIGURES)** cut by transversals (one of which he drew for a different purpose) and the application of the parallel theorems

(FACTS) results in some new information **(FOLLOWS)** which makes his hitherto unavailable triangles of service, and he is able to complete the purpose for which he originally drew the diagonal. He may have several FIGURES from which to draw his FACTS and FOLLOWS. In such case he must exhaust the different possibilities as to FIGURE and FOLLOWS, to either strike the fertile one at last, or find that his predetermined construction is futile, and that he must make a new predetermination.

This gives the mentally sluggish or backward student a chance to change his mental inactivity and unpreparedness into the digital activity of running his finger over the tabulated tools (*loc. cit.*) and trying them out, **3 W's** one at a time, followed by the digital activity of running his finger down the line of diagrams **3 F's** until he finds a recognizable figure in his own diagram, from which to draw inferences.

To find **WHAT** figure **(3 W's)** run over the tabulation until a diagram is found which will apparently do the work, compare lines, etc.

To find what **FIGURE (3 F's)** run the finger down the diagrams, etc.

With the **3 W's** and the **3 F's** the most stolid learner can do something else than sit in staring silence under the belief that he does not know *what to do next.*

He does know. The list of directions is perfectly plain. Hunt dominant operation. Hunt the **3 W's.** Hunt the **3 F's.** He can run his finger over the list of dominant operations and make a selection, right or wrong; and so on through the **3 W's** and the **3 F's.** At the worst it is clerical work which any brain can do as well as it can any other selective clerical work. He can hunt the individual diagrams, patent before his eyes in the main diagram, and tabulate the facts and results. He can have no excuse for not moving, for there is always something definite to be done, mechanically perhaps, but as definite as any classification of observed facts can be. It becomes at least an exercise in observation, if nothing more. It is well to have the results which *follow* the *facts* marked in the diagram itself, equal angles with the same letters, and so on; it makes it so much easier to apprehend the facts in the diagram.

Having exhausted the figures of the diagram and stated the **FOLLOWS**, start over again; what newly available figure in the diagram with its facts and followings. The previous results may make a new triangle available, as in the example above.

In this way there is no excuse for the most sluggish not doing something, tabulation of results at least, even if unable to draw the inferences from the results. Neglect of this predetermination of procedure, and slavish adherence to the hereditary method of type forms, has had its effect even on the writers of the textbooks. I cited one case above.

Another case is that found in a recent book, one of the popular geometries of the class room, namely:

Theorem: In the same or equal circles equal chords are equidistant from the center.

Given: AB and CD, equal chords of the circle,

To prove that AB and CD are equidistant, etc.

Proof: Draw OP perpendicular to AB, etc.

Now this is perfect nonsense from an analytical point of view. The word "distant" makes the right angle which determines distance a part of the hypothesis and not a part of the construction. Distance is, by convention, measured along a 90° line. It might have been conventionally measured along a 30° or a 45° line, as in the case of some projections. Which of these it is, is the part of the hypothesis to determine, and if one draws a diagram on which to mark all the metrical elements which determine whether the lines perpendicular to the chords are equal or not, the right angles will be essential elements of the diagram. Without these the student cannot determine what two lines he is comparing.

If his conclusion is in the definite form of an equation

$$OP = OQ,$$

then the right angles are forced into the hypothesis. There is no other place for them. The right angles in the hypothesis would distinguish the theorem from its neighbors in which the angles are 30° or 45°.

It is the neglect of this equational definiteness of statement that has produced much of the class room confusion in the subject, and that led to the analytical nonsense cited above. The current analysis overlooks the fact that under the head "given," in addition to the equality of the chords should also be included the size of the angles which determine what kind of distance to measure, whether orthogonal, isometric or cabinet distance.

The pedagogy of *type memorization* ought to be superseded by the pedagogy of *selective processes*, and until this is done the teaching of geometry is shorn of half its power and force. The method of matching types ought to be superseded by the method

of selecting processes, and until this is done the teacher will continue to be troubled and tormented with the characteristic uncertain and blind groping which has been the bane of geometry. Until this is done the dictum of Ufer is violated grossly and fundamentally.

May I make my criticism constructive by citing, with due deference, the procedure in my own class room? The student is required to produce the following analysis of the theorems. THEOREM: stated in full, in any correct form. GENERAL HYPOTHESIS: unmetrical elements given. SPECIAL HYPOTHESIS: metrical elements stated in the form of an equation (or inequation) between definite elements, so that we can see what the student thinks is going to be the causal basis of his conclusion, as distinguished from the causes which produce a different conclusion. Definite equations are rigorously insisted upon, with rare exceptions. CONCLUSION: an equation (or inequation) between two specific elements. A definite equation is rigidly insisted upon, with rare exceptions. STATEMENT DIAGRAM: in which the metrical elements of the hypothesis are definitely designated, the measured (relatively or absolutely) lines, angles, surfaces. The measured lines to be drawn very heavy so as to catch the eye: the measured angles designated by heavy letters. DOMINANT OPERATION designated, based upon the equation of the conclusion. PROOF DIAGRAM: same as the statement diagram, plus whatever construction lines the student desires, or perhaps the designation merely of some elements already drawn which he wishes to utilize. All new elements not in the statement diagram must be designated by the initial letters of the alphabet, *a*, *b*, *c*... or by encircled numerals (1), (2)..., exactly in the order of introduction. CONSTRUCTION: designation of the parts constructed in the proof diagram, but emphatically and positively not unless accompanied with the **3 W's**. **3 W's**, with full answers for each, to accompany the heading "Construction." No construction statement accepted without them. **3 F's** with full statement for each. **3 F's**, repeated in view of new information derived from the previous **3 F's**, and so on.

If any "trap is sprung" it is a trap of the student's own setting, deliberately done, with "malice" aforethought, of his own devising, done premeditatedly, with a well-defined intention, with a prevision of what he expects and wants, and of the *processes* necessary to accomplish that end. He is learning processes, not memorizing types. Does not this satisfy Ufer's dictum?

THE APPLICATION OF MATHEMATICS TO PROBLEMS OF THE SHOP.[1]

By K. G. Smith,
University of Wisconsin.

It occurs to me that to indicate the true spirit and intention of this paper its title should be not "Mathematics Applied to the Problems of the Shop," but "The Shop Applied to the Problems of Mathematics." In our technical schools mathematics is applied to problems of the shop and has been for many years. In this line of teaching the shop or designing room furnishes the problem, and mathematics the key. Our problem for discussion, I take it, is mathematics, and the shop is to furnish the key for the teaching of its principles and the solution of its problems. To my mind the latter problem as a whole is the more difficult, and to the man engaged in industrial teaching it is the more important.

Those of you who expect to hear a treatise on difficult problems of design and construction are going to be disappointed. Such problems belong to the realm of "Applied Mathematics" and should be discussed by a mathematician. Our problems belong to the realm of "Applied Shop," if I may use the term, and are to be discussed from the standpoint of a shop teacher, who is not, and, if at the expense of shop experience, ought not to be an expert mathematician.

My experience in teaching this applied shop has been confined to apprentice boys in various trades, older men whose education has been neglected, or in general to what is known as "continuation school" work. Men enrolled in these courses have use only for simple arithmetic, geometry, algebra, and trigonometry, and many do not need to use or cannot use a knowledge of all of these subjects. For instance, a knowledge of trigonometry is unnecessary for the foundryman, but useful to the machinist, pattern-maker, or electrician.

In Wisconsin for the past few years there has been no law to compel the manufacturer to educate apprentices, and when "education was carried to the workingman," as the trite expression goes, he made his demands felt, for he was the one to be suited. Those of us who taught this work were hard put to it. The boy or man came to class if he liked the teacher, the course, and the way it was taught. If not, he stayed away and didn't hesitate to criticise the teacher, the course, and the system. It has been

[1] Read before the physics section of the Central Association at Lewis Institute, Chicago, Dec. 1, 1911.

a good school for all of us and the university rule of principles first and application afterwards, has had to give way to the rule, application first and principles afterward.

Right here there is a difference between the teaching of shop mathematics in a technical high school or a technical course in a high school where boys are looking forward to a shop career, and the teaching of this subject to the boys already employed in the shops who have a half a day per week or less to devote to study. In the technical high school a foundation is laid for the solution of future problems, and consequently highly-specialized work is not advisable or necessary. To the boy already in the shop we must give the work especially adapted to his needs and build up his knowledge of mathematics on the foundation of shop experience already gained. This limits our field and renders specialization necessary.

Now this is not intended to convey the idea that certain general work and fundamental principles are not necessary. Fundamentals are necessary and drill work is necessary, but application is the sword of Damocles, which continually hangs over the teacher's head. For this very reason shop problems, not problems of design or engineering problems, are simple and the knowledge of mathematics required for their solution is not wide. To select problems, to make them practical and to relate them to the things with which the apprentice or workman is familiar, is not easy and here is where ingenuity, knowledge, and shop experience are required on the part of the teacher.

PROBLEMS, THEIR SOURCE AND METHOD OF PRESENTATION.

I hesitate to make statements in regard to this subject because as yet we know so little about industrial education as a whole, and less still about the best methods to be used for teaching special lines. There are, however, certain principles which I believe may well be followed in selecting and presenting any kind of shop problem.

First and foremost, I wish to say emphatically that I do not believe a course in shop mathematics can be properly written by a man who stays in his office and refers to catalogues and other information furnished him in book or pamphlet form. Shop mathematics should be written in the shop or shops by a shop man. This leads me to my first principle.

1. Shop problems should come from the shop and not from the brain of the teacher, especially if he has had little or no shop experience. Problems illustrated by pulleys and gears instead

of by potatoes and dollars, are not necessarily shop problems. Good problems in mathematics are not necessarily good shop problems. The problem of finding the exact length of a belt to connect two pulleys is a good mathematical problem but a very poor shop problem. A steel tape is the best shop solution.

The man who writes the problems should be a shop man by experience and sympathy, and by a shop man, I mean a man who has had actual working experience in a commercial shop and not merely in the draughting room. He should study the shop to get his problems. In teaching local classes, problems may be taken from the very shop in which the students work and may sometimes represent the very job on which a boy is working. A number of closely related problems may be given in order to fix the general method of procedure in their solution. Often a foreman can give valuable information as to what his boys ought to know, but the teacher must have sufficient judgment to decide how much of this can be given by class room instruction.

2. Shop problems should be stated in terms of the shop even if such a statement would not be clear to a student unfamiliar with the shop. Explain if necessary, but do not put the explanation in the statement of the example. For instance, take this example: "Find the taper per foot to be used in turning a pulley with a 12-inch face crowned ⅛ inch." I would prefer to state the example in that way rather than to say: "Find the taper per foot to be used in turning a pulley with a 12-inch face ¼ inch larger in diameter at the center than at the edge." In other words, I do not think we should be afraid of technical terms in stating shop problems. Shop terms a boy must learn, for in these terms orders will be issued to him. Many times a shop term with which he is familiar conveys a more definite idea to his mind than a carefully-worded explanation.

3. The data of shop problems should be given in accordance with shop usage and the results obtained should represent good practice. To say that a gear has a pitch diameter of 3 1/7 inches is not in accordance with shop usage, though I saw this given as part of a problem in a book on shop mathematics. It might be good drill for the boy to reduce 1/7 to the form of a decimal, but he would not find it common practice to give pitch diameters in odd fractions of an inch. I do not believe it a good plan to distort examples for the sake of arithmetical drill.

Another example I saw the other day: "The tailstock of a lathe can be offset three inches, what is the greatest taper which

can be turned on a piece six inches long?" Evidently, the author had in mind that the piece could be turned to the form of a cone whose altitude and diameter of base were each six inches. It would be practically impossible to turn such a piece with any degree of accuracy by offsetting the tailstock of a lathe, and this method would not be used.

As an illustration of results obtained not representing good practice, I worked an example the other day in which it was required to find the mean effective pressure necessary in a gas engine of a certain size and speed to develop a given horsepower. The answer came out ten pounds and a fraction. A mean effective pressure of ten pounds in a gas engine does not represent normal conditions nor good practice.

4. A problem should not be made unnecessarily complicated simply to make it apparently harder to solve.

For example, the following: "A shop is run by a motor belted to a lineshaft. The lineshaft was to run at 300 R. P. M. and the motor at 1,200 R. P. M. A 40 inch pulley was put in the lineshaft and a 10 inch on the motor. On starting, the motor was found to run 1,400 R. P. M. Determine the proper size of pulley on the motor to give 300 R. P. M. at the lineshaft."

The whole question hinges on the fact that the motor does run 1,400 R. P. M. That it was expected to run 1,200 R. P. M. has nothing to do with the question and is apt to cause confusion.

5. Do not confuse shop problems and problems of design. No hard and fast line can be drawn between shop problems and problems of design, but the shop teacher is constantly tempted to use problems for shopmen which are really problems of design, partly because they are interesting and partly because they are the easiest to formulate or to find in books. There are two reasons for not giving such problems. (1) They are not so useful to the boy as plain shop problems. (2) The boy's employer expects his apprentice to be educated for the shop and not for the draughting room. It is better for the boy to be a good shopman than a poor draughtsman.

There is a field of "shop mechanics" if I may call it so, with which a shopman ought to be familiar, though you may say that all of it is design. Such topics as the lever, the wheel and axle, the pulley blocks, the differential and spur-gear hoist, the screw, wedge, and inclined plane, horse power of engines and motors, horse power of belting and shafting and the simplest rules for horse power of gearing, pulley and gear ratios and

simple stresses in the study of strength of materials, all have a place here.

Friction coefficients, complicated rules for horse power of gearing, empirical formulas for horse power of rope drives, proportions of pulley arms and hubs and other machine parts, heating surface of boilers, are problems for the engineer and designer and not for the shopman.

6. In the presenting of shop problems use the actual thing whenever possible. For instance, if you ask a boy how many one inch studs 2 1/8 inches long can be cut from a ten foot bar of cold rolled steel allowing 1/8 inch on each for cutting off and finishing; get the bar, if possible, at least the first time, and let him measure it. If you talk about hexagons get a hex head bolt or hex nut. If emery stones are under discussion, get one. If you are discussing the differential hoist get one, and carry it to the class room even if it is heavy. The results obtained make up for it. In a word, make examples as concrete as possible and do not waste time describing and explaining when the thing itself can be bought, begged, borrowed, or stolen. If the actual things cannot be obtained, use sketches as the next best means of illustration.

7. Use good practical shop sense in accuracy of measurement necessary in interpreting and getting results to problems given. If, for instance, a result is obtained giving the diameter of pulley pins necessary as 39.2 inches, teach the boy to use the nearest standard size, a 40 inch, and don't let him consider 39.2 inches the practical shopman's answer. I saw only a few days ago the length of bar necessary on a jack screw given as 7.937 inches. Levers on jack screws are not measured to thousandths of an inch. This applies to results obtained during the solution of problems. Teach boys to interpret their answers continually by the rule of standard practice and shop sense as to accuracy necessary and they will take pride in thus applying their experience.

8. Take time to explain the mechanical and physical whys and wherefores, but do not spend time explaining mathematical whys and wherefores unless a boy is particularly interested in this subject. For instance, do not stop to explain why the divisor is inverted when dividing by a fraction.

The above general principles, in my opinion, should govern the application of the shop to all grades of mathematics from simple arithmetic to trigonometry, though, as I said at the beginning,

no one can as yet lay down any rules for industrial teaching because we know so little about methods and possibilities.

In order to place something definite before you I have outlined on charts some shop topics especially applicable to the teaching of certain subjects in arithmetic, algebra, and geometry. It is impossible to go into detail for every teacher must work in the shop and study for himself.

Though many of them are so simple that you may smile, I can assure you that the teaching of these things to shop boys is a problem well worth study and the presentation of them to shop boys, taxes energy, enthusiasm, and resourcefulness to the highest degree. And when boys come for assistance in their problems and get that which is of actual use to them or when they say: "I figured that job myself the other day," I think the teacher may count himself as one who is assisting in the industrial progress of this nation as truly as the engineer who designs a locomotive or spans a chasm with a bridge.

NEW MAXIMUM TO HIGH SCHOOL TEACHERS IN CHICAGO.

Announcement is made by the Board of Education of Chicago of a new maximum for high school teachers of $2,600. As fixed, this figure ranks with the best schedules effective in the United States, only New York City exceeding it by $50, and Boston by $18 for recent appointees; the difference in cost of living in these two, however, far more than offsets the difference in schedule. Friends of better public education in Chicago have long struggled for this result, and are now hopeful that a way has been provided for getting and keeping the very best teachers in the United States. The grant of a new and generous schedule has evoked a feeling of gratitude from teachers now in service in Chicago, and they have responded by a communication of thanks to the Board, and by laying plans advertising appropriately the new order of things in the best educational journals in the country.

Of course this new grant has been tardily made. For several years the lists of eligible teachers have contained few or no names of science teachers, though lists of teachers of the other subjects have usually been crowded. Just now there are no names on the eligible list to teach zoology, chemistry, physics, and but three in mathematics. In view of the proposed opening next year of two new high schools there will most likely be a demand for teachers in all departments of science, mathematics, and manual training. Examinations will probably be held June24 and 25. Inquiries may be addressed to Department of Examinations, Room 828, Tribune Building, Chicago.

Candidates for general certificates of teachers of academic subjects in high schools must present in advance credentials showing the following:

1. (*a*) Graduation from an accredited college, and (*b*) two years of successful experience in graded schools of good standing; or
2. (*a*) Graduation from an accredited college, and (*b*) completion of the required work in the Chicago Teachers' College, and (*c*) one year of successful experience in graded schools.

They will be examined in one major and four minor subjects, as indicated below, and must attain a general average of eighty per cent with no subject below fifty per cent; *provided*, that the major subject shall not be the same as any of the minor subjects; and *provided*, that professional study shall be required of all candidates as a minor subject; and *provided*, that English shall be required of all candidates as a minor subject unless selected as a major subject.

Majors: English, Latin, Greek, French, German, Spanish, Polish, physiography, botany, zoölogy, physiology and sanitation, physics, chemistry, mathematics, commercial geography, commercial law, accounting, phonography, ancient and mediæval history, history of modern continental Europe, English and American history.

Minors: Professional study, English, Latin, Greek, French, German, Spanish, Polish, physiography, botany, zoölogy, physiology and sanitation, physics, chemistry, astronomy, geology, mathematics, general history and civics, civics and political economy, commercial geography, commercial law, accounting, phonography.

SCHEDULE OF SALARIES.

1. Principals of Elementary Schools.

Lower group—	
First year	$1,800
Ninth and subsequent years	2,600
Upper group—	
First year	$2,700
Fourteenth and subsequent years	3,500

2. Teachers in High Schools.

A. For teachers holding general certificates.

Lower group—	
First year	$1,000
Seventh and subsequent years	1,600

Schedule as amended (1912).

Upper group—	
First year	$1,700
Second year	1,800
Third year	1,900
Fourth year	2,000
Fifth year	2,100
Sixth year	2,200
Seventh year	2,300
Eighth year	2,400
Ninth year	2,500
Tenth and subsequent years	2,600

Flexible Mirror.—Apply to a sheet of paper or of fabric coated with egg white one or two coatings of transparent varnish and before it is quite dry apply a sheet of tinfoil to it. When this adheres properly, pour quicksilver on it, as is customary in coating, moisten the paper and strip it off.

SOME EFFECTS OF CIVIC BIOLOGY IN THE HOME.

By Jean Dawson,
Cleveland Normal School.

By civic biology, I mean that phase of the subject that is vital to the individual and community life, as distinguished from the general biology (which in many of our secondary schools is but an abridgment of college biology), which does not consider human welfare at all. Civic biology is grouped about man and his needs, while the time-honored general biology has evolution as its central thread.

Civic biology eliminates all forms of plant and animal life that do not help in the life struggle of the student in the community in which he is living. A course in civic biology, therefore, must embrace more or less economic entomology, forestry, bacteriology, hygiene, sanitation, etc., as well as much that is now taught in courses of elementary agriculture.

In working out a course in civic biology for the Cleveland Normal School, I am not letting sentiment stand in my way, but am breaking loose from all the shackles of biological traditions, which serve to hinder the establishment of a course founded on the bed rock of civic betterment.

The pity is, not that all that is interesting in biology cannot be taught, but that the time and energy, which can be devoted to the subject, is so limited that much that is useful and even necessary must be eliminated. The problem of the teacher becomes one of selecting that which is vital from that which is merely useful.

I am not insensible to the wail, "Save the cultural side of biology," that is going up from people who believe that a course in biology that is civic or economic cannot therefore be cultural. To such, I would say, the vital and cultural phases of biology are inseparably united. No phase of biology, or any other subject for that matter, can be cultural that does not lift the student to a higher plane of living. The attainment of useless knowledge cannot do this, and leads to disgust or to pedantry. I may add that useful and even the vital phases of the subject, will stop short of being cultural, if it does not permeate and soak through into acts which uplift.

Whenever any subject or phase of subject so uplifts a student, the result is always reflected back into the home. Every normal

child naturally seeks to tell his loved ones everything which he has learned that is of real benefit.

One girl wrote to me long after she had finished the course: "I used to worry about my averages in school, but somehow I never thought of my standings in biology. The biology course reveals so many interesting things to me, that sometimes I could hardly wait until I reached home to tell my mother. The knowledge of civic biology was so badly needed in our home that it was impossible for me to keep quiet on the subject."

This young lady's mother told me that she believed that the family got almost as much from the course as her daughter did.

I have come to judge the real results of my courses, not by the examination papers, but by the amount of work that my students carry away and apply in their homes.

But you say you cannot apply such a criterion to all subjects taught in our schools. It is a well-known fact that school life is one thing, and home life is another, and that relatively few things taught in the school can be applied in the home. I reply that the divorce of school and home means one thing, and only one thing, and that is that the school work is not meeting the vital needs of the people. In planning a course, I have often been aided by the reactions of the student body. For instance, before writing this paper I asked a class, which had passed the course, to tell me what part of their biology work they had applied in their homes. The results were very gratifying, and I shall take the liberty of frequently quoting from their statements.

One often hears the criticisms about our schools which some of these girls have unwittingly expressed. One girl writes:

"The first thing that I would like to say does not apply to your question, still it seems so very important to me that I want to tell you about it and that is the attitude which the home folks take toward my school life. All during high school they had no sympathy for me in my studies. When I began to study geometry, etc., they would all say, 'Now, what's the use of her learning all that; it will never do her any good. She might just as well quit now and go to business college!' To avoid these unpleasant remarks, I never mentioned school any more than I had to. Now everything seems different, when I go home and talk to the older ones about the forestry problems, the contamination of our drinking water with sewage, the work the birds are doing in checking the insect devastations, how to exterminate the flies, and so on, they are all so interested, and think that at last I am

beginning to learn something. Going to business college now seems to be a thing of the past."

This dissatisfaction is expressed by another girl in the following: "I have often asked myself with reference to my various subjects in high school especially: 'Why am I studying this?' or 'Is this worth learning?' The only answer that I could give was: 'It is to develop my power of reasoning or that I am being educated.' But these answers were merely excuses, it seems to me, for they did not satisfy me at all. When I began the study of biology, I found what I had been looking for—something that does more than develop the mind and impart knowledge; something which has a definite purpose in view.

"Knowledge which cannot be put to use is worthless. Civic biology is one of the very few subjects, the knowledge of which has been of practical use to me. In fact, it is often said of most studies, by our teachers: 'It is not what we learn, for that we will soon forget, but it is the power to gain knowledge, which is of importance.' This is true, but there are some things which we cannot forget, because we continually use them and apply them in our daily lives. Civic biology is such. We cannot exist on this earth without coming in contact with many, if not all of these great biological problems, such as disease, its causes, prevention and cure; our food supply, its cost, abundance, and the cause of its being damaged at times; our lumber supply, determined by the method of handling the forest.

"Although my high school education had broadened my mind somewhat, the one year of civic biology did more toward giving me a broad outlook on life and a desire to do something in this world, than all the rest of my schooling put together."

I do not quote the above students with any desire to impress you with the idea that biology is the most important subject in the curriculum. I do wish, however, to say that I believe that each and every subject in our schools should be reorganized, if they have not already been, to more closely meet the needs of the people. This will take time and much hard work, but I believe that it is in the direction toward which modern education is tending.

My paper to-day does not call for an outline of the course, and I shall make no effort to indicate the scope of the work. Should anyone care to know what is taught under the title "civic biology" in the Cleveland Normal School he can find what he de-

sires by looking in the March number of SCHOOL SCIENCE AND MATHEMATICS for the year 1911.

I may say in passing, however, that much time is spent out of doors in the spring and fall collecting and studying. The student does most of the collecting out of school hours, individually or in groups, after he has been shown what material is desired. Great emphasis is laid upon the study of plants and animals in their natural environment before bringing them into the laboratory; tests are held in both field and laboratory, and records are kept of the material collected by each student.

While the class is becoming acquainted with the common native trees, shrubs, weeds, fungous diseases, insects, native birds, etc., he is learning in the laboratory and class room, what these forms of life are doing, which make them of civic importance.

I always picture civic biology to myself as a tree whose branches terminate in the home, community, city, state, and nation. The home branch, of which I am speaking to-day, would be much larger and more powerful if the home had been previously stimulated by the proper kind of nature study. As it is, the student must stop to become acquainted with much that he should have learned in the grades. A junior girl expresses this thought in the following:

"The children at home are always much interested in my work, with the birds, trees, and weeds. I was certainly surprised at the way in which they learn many of them. My little brother, only five years old, knows many of the trees. I often think that while a child he will have learned all the common trees, and when he is older he will have all his time to devote to the problems concerning them."

In choosing subjects for special study, we try to select the problems which the student can help to solve through his own individual or class effort. To illustrate: no insect holds the interest for the normal girl that the housefly does. She has studied its life history, and has learned that no place is too filthy for flies to swarm, and from these unnamable places where they lay their eggs, and breed, they fly to distribute filth with germ-laden feet on everything they touch. A single fly may carry as high as 6,000,000 germs; the kind depending whether it has been dabbling in tubercular sputum, typhoid dejecta, decaying animals, or other filth.

Stimulated by the results of Dr. Hodge's focal method which gets the flies before they enter the house, to do damage, the girls

began a preliminary campaign last summer to rid Cleveland of this most dangerous of pests. The results were most encouraging, and the girls are now planning to extend the work to cover the entire city, having as their slogan "Cleveland, the flyless city," for the year 1912. The city will be divided into sections, with one or two girls in each, to direct and encourage the work of trapping flies and reporting breeding places to the board of health.

The work which has yielded the most good, because it teaches sanitation and preventative medicine, is a course in elementary bacteriology. The student gains a clear idea and understanding of the nature, growth, reproduction, and work of germs, and acquires a knowledge of the causes, and the means of prevention of all the contagious diseases.

Much of the mystery that surrounds germs is cleared away and the student begins to regard these little plants much as he does the higher plants of the garden and field. Considerable care is taken to dispel the notion that is so often held by people, namely, that all germs are dangerous; and to establish the fact that there are probably no more disease-producing germs than there are poisonous species among the higher plants. The attention of the class is directed toward the control and extermination of the disease germs much as the energy of the people has been in the past directed toward the extermination of poisonous plants and snakes.

Considerable time is spent, learning through experiment, the conditions necessary for the best growth and the methods of killing germs. The retarding effects of cold on the growth of bacteria makes clear the necessity of keeping food in refrigerators and cold storage; the plan of keeping food by killing all bacteria as in canning fruit and vegetables; and the use of chemicals as preservatives in foods.

Excursions are taken to bake shops, markets, factories, and dairies to see how food is handled, and the student learns the difference between things that look clean and things that are bacteriologically clean.

The class learns that disease-producing germs come from the bodies of those sick with the disease and that these germs gain entrance to the bodies of the well through the mouth, respiratory tract, and through wounds in the skin; that germs are carried through direct contact, water, milk, air, uncooked food, and by animals, as the fly, the flea, lice, pet cats, rabbits and dogs.

The cause and means of disseminating the germs and the prevention of each contagious disease is studied. Especial attention is given to tuberculosis and to typhoid fever, because of the contamination of our drinking water with sewage.

The class has the reports of the latest medical researches and keeps in close touch with the practical work in the city. Excursions are taken to school clinics, tubercular exhibits, sanataria and baby dispensaries. Lectures and demonstrations are given before the class by members of the board of health, school physicians and members of the associated charities.

The student realizes that careful as he may be, he cannot wholly prevent disease germs from entering his body and that he must rely upon the germicidal power of his blood if he would escape disease. With this end in view, he seeks to take the required amount of fresh air, exercise, baths, etc.

One girl expresses her opinion of the work as follows:

"Until I studied bacteriology, I didn't realize that the basis of all success in life is health, and that the health depends largely upon a knowledge of our friends and enemies in the animal and plant kingdoms. Civic biology lays the foundation for a practical knowledge of how to keep healthy."

While instances of improving home grounds, protecting birds and toads, discouraging stray cats and English sparrows about their homes, are oft repeated in these reports, the work that has borne the best fruits is the knowledge which has caused them to struggle for greater physical efficiency.

All speak of their efforts to convince the home people of the necessity of letting sunshine into the house, airing the rooms, sleeping with their windows open, and taking daily walks and baths. Here is an extract from a girl's paper, illustrating the attitude of the family toward the work. "At first the newest things always meet with opposition. It has been a hard struggle, and many times I have been laughed at by my family. I have gone right ahead though, and now I notice that instead of laughing they listen, and are doing all the things that I am required to do. I don't mind the fun that they have made of me, for I feel that I have been pretty successful."

Perhaps the character of the work that is being reflected back in the homes may be best illustrated if I read one or two reports verbatim:

EFFECTS OF CIVIC BIOLOGY IN MY HOME.

"Both the housekeeping and the health of the members of our family have been improved by the application of my knowledge of civic biology.

"Before I had studied bacteriology in the normal school, our house was kept in a somewhat different manner from what it is to-day. Although it was what any ordinary good housekeeper would have termed clean, it was not a model of sanitation. The feather duster was ever in use, spreading the dust and germs throughout the air. The windows were opened only on cleaning days; the temperature of the rooms was always 80° F. and above; the shades were usually drawn during the day, especially in the unused rooms, and the floors were covered with heavy carpets. In the summer, flies were present, no matter how well the house was screened. Although we felt their annoyance, we never dreamed that they were carrying germs from one place to another and into our home. No one ever thought that they could be exterminated, we had always had flies, and we supposed that we must always have them.

"These conditions no longer exist. In planning and caring for our new home, civic biology decided many points. In the first place, we chose a lot out of the city, in a high open space near the lake. The floors of our house are all polished, covered only with small rugs, here and there, which are easily carried out of doors and shaken. A vacuum cleaner now does the sweeping, and either an oiled or wet dust cloth is used. We now open the windows every day, even in the coldest weather, and we keep the temperature between 68° and 70° F. The windows are free from curtains, which are merely dust catchers, and added labor to keep clean. The shades are seldom down. Our house is nearly as light as a greenhouse, there are so many windows in it. There are no dark corners, where germs may collect and live without disturbance. No less than three porches would suit us now. A large porch across the front of the house, one at the back, and a sleeping porch upstairs, the whole width of the house. After learning the value of sleeping out of doors we never could own a house without such a sleeping porch.

"The fly problem is now being solved in our home, as well as in others near by, as a result of civic biology. With a doing away of the breeding places, and the use of traps, we will soon need no screens. Last summer the flies were in the traps instead of in the house, and who knows how much disease was prevented

by the elimination of these insects from the home? The study of biology in the school has had its influence in the method of preparing and caring for our food. We no longer allow the milk to stand in a warm place or uncovered, since I have learned how rapidly germs multiply in milk in such conditions. Our water is also boiled and cooled to render it safe for drinking purposes. We are very careful about buying edibles which are exposed to the dust or handling of other people. Not one of us would think of using a public drinking cup or towel. Of course we knew it was not just the right thing to use the public towels, etc., before we studied biology, but until we knew why we were not so careful.

"The health of each member of the family has also been benefited by this knowledge. Our endurance has been increased, through daily walks in the fresh air and refreshing cold baths in the morning. Since we know about how much food and sleep a person ought to have under certain conditions, we now keep at the top notch of efficiency. Minor ailments have entirely disappeared from our family, and we no longer catch every disease that comes along. My desire for a garden and for taming birds has arisen directly from my study of biology. We are now planning to beautify our home grounds, and to cultivate the soil about it."

To quote another paper:

"We have a summer home in the country, and our lives there have been greatly benefited by my course in biology. Our trees have been sprayed and pruned, and better fruit has resulted from my knowledge of plant diseases and insect pests. Our country home is near South Newburg, near Snow Lake. The water is stagnant, and many mosquitoes breed in it. Last spring when we went to the country, I told the neighbor boys the story of mosquitoes and where they lived and bred. The boys became interested, and with the aid of kerosene oil have relieved us of these pests. They also have become interested in birds and trees, and when I go down there they ask me a great many questions, and tell me what they have seen and read. Our family boil the drinking water, and sleep with their windows thrown open. I now keep more regular hours, walk in the open air and take cold baths every morning. In consequence, I feel invigorated and good for something. In the past week or so, two of my brothers and a sister have started to take cold water baths, because they have noticed a change in me. Before I started to

take these baths I was cross and irritable in the morning, and sometimes half asleep for an hour or more before fully awakening. Now my baths wake me up and make me feel glad that I'm alive.

"From my knowledge of tuberculosis, I think I have prevented my sister from having this dreadful disease. Last spring she lost her appetite and ambition, and was in a general run-down condition. I took her temperature several times each day for about a week and found that it always increased considerably in the afternoon. I knew that these were symptoms of tuberculosis, and I had her go to the doctor. He confirmed my suspicions, that she was in the incipient stage of tuberculosis, and made her take a complete rest, plenty of fresh eggs and milk, and kept her out of doors day and night. Now she is well and takes her walks with me every morning and feels fine. I never shall cease to feel grateful that I was able to discover the disease in time to prevent it."

Is this phase of biology worth while? Is it meeting the needs of the people? Is it uniting the work of the school with the home in a wholesome way? Is it raising the lives of the people to a higher plane, and becoming cultural as well as vital? These are questions which I will leave for you to decide.

In closing, I would say that this work is but well begun. When civic biology is universally taught, and the rising generation have become educated to the necessity of working together for the good of the whole, then they will throw off the needless shackles of ill-health and disease which have so long held them in its ghastly bondage, and will solve their problems as only healthy, intelligent Americans can. They will have safe drinking water, sanitary homes, factories and offices; they will hold the price of human life in higher esteem, as food becomes purer and prices become lower. Smoke consumers will make it possible to restore the beautiful trees, so that Cleveland may again lay a rightful claim to the title of "Forest City." Flies will not be allowed to pollute our food with typhoid and tubercular germs, and death will not rob thousands of our homes of their children through contaminated milk. Gardens will flourish in the waste places, homes will be festooned with roses and wistaria, and the song birds will return to furnish us with the sweetest of all nature's music.

THE USE TO BE MADE OF THE ORTHOPTERA IN BEGINNING COURSES IN ZOOLOGY THE SEQUENCE OF THE COURSE.[1]

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Introduction.

"Aller anfang ist schwere," this old maxim repeats itself with added emphasis as the zoölogy instructor, year after year, starts new classes in the study of animal life.

The diversity of opinion as to what is most worth while, and what is the best point of attack, is well shown by the variety of arrangement of subject-matter, types, and phyla in the various modern texts and laboratory manuals.

Loyd and Bigelow in their excellent work on the "Teaching of Biology" discuss the use of the crayfish, mammal, frog, insect, and protozoa as beginning laboratory types, and decide in favor of the crayfish. It is not my purpose at this time to enter into a discussion of the relative merits of the various types; I wish merely to suggest some of the uses that can be made of the grasshopper and its allies, based upon repeated experimental tests.

During the past eleven years, I have started every fall from twenty-five to fifty beginners in the study of animal life, not only beginners in zoölogy, but, as a rule, students doing their first biological work and usually their first laboratory science. It is for these untutored classes, that the plan of work herein briefly outlined is recommended, as it has been found to give good results.

Advantages Offered by the Orthoptera.

For fall classes—there would be no reason for using the grasshopper for other than fall classes—the grasshopper affords an abundance of material. Every campus, vacant lot, field, or back yard is more or less alive with Orthoptera insects in September. This gives excellent opportunity for field work and studying the living animal under natural conditions. The abundance of these insects enables the instructor to provide specimens in quantity, and what is more to the point, the material can always be fresh or alive if desired. Every laboratory teacher knows that preserved specimens of any kind are often so disagreeable to the beginner, either in fact or fancy, that interest in the work is actually retarded. With fresh material much of this first recoil

[1]Read before the Oklahoma Academy of Science, December, 1911.

is overcome, and the new laboratory worker comes to his task with zest.

Morphology.

For training in the study of structure, observation, and scientific drawing, the grasshopper is very satisfactory. Such large species as the American (Schistocerca Americana), the Lubberly (Hippiscus rugosus), the Carolina (Dissosteria Carolina), or the yellow (Melanoplus differentiallis) are always available.

Where will one find more diagrammatic and schematic studies for first drawings and clear cut observation practice than the posterior leg of a grasshopper, a side view of the entire animal with the wings removed, or even a front view of the head? For the first work with the lens and low power of the compound microscope the antennæ, foot, and tibia of a fore leg are unexcelled. The student can prepare his own material, learn to manipulate his slide on the microscope stand as he studies the characteristics of the twenty odd segments of the antennæ or the tarsi of the foot. For the high power work and an early lesson in the appreciation of the new world opened up by the microscope, I know of no better objects than well-mounted specimens to show the abdominal spiracles and facets of the compound eye.

For the morphology side of the study there is work enough for five or six lessons, and the work is such that the exactness and accuracy that can be secured even at the first of the work makes the young beginner feel that he is getting results. And at the same time he is being trained in laboratory methods, drawing, and observation in a way that will make his future progress easy and sure.

Field Work.

If there were no other consideration, the unequaled value of the Orthoptera for field work places it above all other groups as the best entering wedge to the study of animal life. The species are rather distinct; common names may be used to advantage; and while the species are numerous enough to give variety, they are not so abundant or intricate as to be confusing. The crickets, cockroaches, katydids, walking sticks, and mantids afford an abundance of data for comparison and habit studies. Excellent illustrations abound for the study of adaptation from many angles. Among the Acrididæ alone, zonal distribution may be worked out with precision and so easily that even a dull novice "catches on." To be concrete, certain species are found upon

the bare ground, others abound in the short grass, still others inhabit only the tall grass, some are found among domesticated plants and weeds, and some frequent wooded margins. After study of this kind has been carried on in the fall months, think of the fund of local illustration that one may employ, when questions of distribution and relation to environment come up during the year's work.

There are also many special topics that may be taken up: stridulation is almost wholly confined to the Orthopterous insects. In the field one may study to advantage the sound-making of coneheads and meadow grasshoppers, in the vivarium, field and tree crickets will perform to order. Moulting—a factor in the development of all Arthropods—can always be studied if nymphs are secured for laboratory observation and kept a few days in live boxes.

Class Work.

The economic relation of animals to man and plants as destroyers of crops and household pests can be studied to advantage with the Orthoptera. There is plenty of material in texts and bulletins for first training in library work.

To illustrate classification, the order Orthoptera, with its well-marked and easily defined families, makes the need and method of classification apparent. Classification can be tried out by the student with specimens he catches in his field work and in this way the beginner clears up points of families, genera, and species, sometimes not comprehended for months.

Discussion.

The use of the grasshopper as a leading type for field and laboratory study is by no means new or untried, but those making extended use of the Orthoptera material are few and far between. It is the old story of "acres of diamonds." In view of the fact that these are among the most abundant fall field insects from Texas to Massachusetts, and that there are at least twenty-five species common to the entire region—as I have verified by my own collecting—it has always seemed to me that many zoölogy teachers lose an excellent advantage in failing to work up a careful acquaintance with the Orthoptera—certainly one of the best and most available groups for introducing animal life to beginners in autumn classes.

Sequence of the Course.

While the laboratory work on the grasshopper which should be intensive is going on, much field work on insects in general

may occupy the time of the class on off laboratory days. Allowing most of the first month for the strictly laboratory work on the grasshopper, the second month may be used to advantage for comparative study of other insects along the line suggested. With this work complete, our introduction to the study of animals will be consummated.

After this we are ready to begin the logical order, and develop our subject from simple to complex. It certainly is a bad mistake to lose the good to be gained from taking up the logical order after the preliminary work has fitted the beginner to handle laboratory work with some facility, follow directions, use the microscope with a little skill, and to grasp fairly well almost any elementary phase of the subject by following the insect work with the crayfish, mussel, worms, etc., as we find outlined in many of our recent texts.

Someone may say: "Why not follow your plan to its ultimate conclusion and begin at the first with the simple and work up to the complex?" For beginners, the work I have outlined is the simple work at the start. We get off easier and gain the splendid opportunity for field work with abundant material and fair weather; furthermore we enlist the interest of the student, give him work that he can manage, and practice in handling laboratory material, using the microscope, and making scientific drawings. The way young students clear up the Protozoa after this preliminary training is a source of satisfaction to all concerned.

ARTICLES IN CURRENT PERIODICALS.

American Botanist for February: "Some Dakota Wild Flowers," by H. Tullsen; "Evergreens in Winter," by Frank Dobbin; "Some Leafless Plants," by Dr. W. W. Bailey; "The Botanist and Public."

Condor for January-February: "The Shore Birds of Santa Barbara (with three photos by J. H. Bowles), J. Hooper Bowles and Alfred B. Howell; "Through Tahoean Mountains," (with three photos by Oluf J. Heinemann), Milton S. Ray; "AVisit to Nootka Sound," (with four photos by the author), H. S. Swarth; "Some Birds of Southwestehn Montana," (with one map), Aretas A. Saunders; "Birds of a Mojave Desert Oasis," Chester Lamb.

Educational Psychology for February: "A Tentative Revision and Extension of the Binet-Simon Measuring Scale of Intelligence," Part I, Lewis M. Terman and H. G. Childs; "Mental Fatigue in Day School Children as Measured by Immediate Memory," Part II, W. H. Winch; "Adding Upward and Downward," Lawrence W. Cole.

Guide to Nature for January: "The Beaver," illustrated, Elliott R. Downing; "The Stars and Planets," S. A. Mitchell; "Aquarium Management," illustrated, William P. Seal.

Journal of Geography for February: "Some Points to Emphasize in Teaching the Geography of Africa," Caroline W. Hotchkiss; "Suggested Modifications in High School Geography," R. H. Whitbeck; "Economic Notes," Edward Van Dyke Robinson; "Elementary Weather Observa-

tions. II," Robert M. Brown; "Local Climatic Peculiarities in their Relation to Intensive Agriculture," Eric Rexford Miller; "The World's Great Rivers—The Danube," Frederick Homburg.

L'Enseignement Mathèmatique for January: "Le calcul fonctionnel," J. Hadamard; "Extraction d'une racine quelconque d'un nombre reèl A," L. Baatard.

Mathematical Gazette for January: "The Place of Mathematics in Girls' Education. An Address and Discussion," Miss S. A. Burstall; "The Aim and Methods of School Algebra. II. Methods of Teaching," T. P. Nunn, D.Sc.; "The Nature of Elementary Mathematics from the Modern Standpoint," C. Elliott.

Photo-Era for February: "Photography as a Pastime," Belmont Odell; "What the Camera Reveals in Los Angeles," Louis Fleckenstein; "Tank-Development with Rodinal," Alfred Watkins; "The Amateur and the Photographic Journal," William Spanton; "Tripak Color Photography," F. E. Ives; "Enlarging with a Soft-Focus Lens," Arthur Hammond; "Snow-Landscapes," Will A. Cadby; "Stand-Development for Lantern-Slides," H. Bernard Ward; "Comparison of Methods of Making Lantern-Slides," Louis Derr.

Physical Review for January: "The Collapse of Thick Cylinders under High Hydrostatic Pressure," P. W. Bridgman; "Electrical Discharge from a Point to a Plane," O. Hovda; "Effect of Frequency on the Capacity of a Condenser, with Kerosene for the Dielectric," S. Herbert Anderson; "A Model of the Elementary Magnet," S. R. Williams; "An Important Practical Problem in Gyrostatic Action," W. S. Franklin.

Popular Astronomy for March: "Is There any Evidence to Justify the Supposition of an Infinite Universe?" B. G. Harrison; "The Variable Stars," Fr. Argelander, continued; "A Pedagogical Suggestion for Teachers of Astronomy," Sarah F. Whiting; "A Modern Look at the Universe," Henry Olerich, continued; "The Occultation of Venus, April 15, 1912, as Visible in the United States," Wm. F. Rigge.

Popular Science Monthly for February: "The International Hygiene Exhibition at Dresden," Dr. Henry G. Beyer; "The Value of Non-Instrumental Weather Observations," Professor Robert DeC. Ward; "Narrow Jaws and Small Feet," Dr. Richard Cole Newton; "Conflict of Administrations," President Frank L. McVey; "Relations of Japan and the United States," President David Starr Jordan; "Old Academy of Science, Paris," Dr. Edward F. Williams; "The History of Gold Mining in the United States," Professor R. A. F. Penrose, Jr.; "Modern Tenement Houses," Jonathan A. Rawson, Jr.; "History of Gymnosperms," Professor John M. Coulter.

Psychological Clinic for February: "School Clinics for Free Medical and Dental Treatment," Lewis M. Terman; "A New Method for Determining Rate of Progress in a Small School System" (concluded), Norman Cameron.

Science for February 16: "The Glaciers and Glaciation of Alaska," Ralph S. Tarr. For February 23: "The Primary Concepts of Physics," William F. Magie.

Scientific American for February 3: "Mapping the Value of Gravitational Force," William Travis; "Savage Irrigation in Luzon," Hamilton Wright.

Unterrichtsblätter für Mathematik und Naturwissenschaften, Nr. 1, 1912: "Ueber die Verwendung von mikrophotographischen Lichtbildern beim zoölogischen und anatomischen Unterricht," Professor Dr. W. Stempell; "Form und Wachsverbrauch der Bienenzelle," Prof. Dr. Heinrich Vogt; "Die Bekämpfung der Rebschädlinge und die Biologie," Dr. F. Schwangart; "Funktionaler Zusammenhang der Lehrsätze des Menelaos und des Ceva," Prof. Dr. Ernst Schultz; "Bemerkungen über die Behandlung der quadratischen Gleichung in elementaren algebraischen Unterricht," Prof. Dr. Karl Goldziher; "Die Kegelschnitte in ihrem analytischen Zusammenhang mit dem geraden Kreiskegel," Dipl.-Ing. Carl Herbst.

THE OPPORTUNITY NOW BEFORE TEACHERS OF PHYSICS.

By J. M. Jameson.
Pratt Institute, Brooklyn.

(Continued from the March number.)

As was suggested in the preceding article, the methods and teaching material which shall adapt the instruction in physics to the everyday needs of the secondary school pupil, and shall thus give the subject its highest direct value, must be developed by those in closest touch both with the subject and with the pupils: in other words by the teachers of physics in secondary schools themselves. They are, or ought to be, the best qualified judges of the capacities and interests of their pupils, and of the possibilities of relating their subject to the particular conditions of the community in which they are teaching. No instruction in physics of the sort here contemplated can be mapped out by those interested in merely the scientific or historical phases of the subject. It must be formulated by those, who in addition to knowing their physics, know and are interested in the applications of physics in the daily processes going on about them. Physics for a school located in an agricultural center, while having to do with the same general principles, must be presented through a different equipment and different applications than would be suited to a school located in a large city; physics teaching for pupils in a textile center must differ, if it is to secure the best results, from the physics teaching in a city in which the manufacture of machinery is the principal industry.

The adaptation of physics teaching on any such scale as this is of course a big undertaking. Success can be looked for only through the coöperation of a large number of teachers. And in an undertaking in which so many are involved, a "clearing house" through which ideas may be exchanged, criticised, and modified; through which material and exercises of proved value may be distributed; working drawings and facilities for the manufacture of equipment and fittings may be provided, etc., therefore becomes of the highest importance. The American Federation Committee on the Improvement of Physics Teaching, which was appointed at the Washington meeting, an account of which appears on page 251 of the March issue, may very properly take these matters in charge. If physics teachers everywhere will actively assist this committee in its work, definite results from which all may benefit may be expected. In this connection, it may be appropriate to state that the working

drawings for the apparatus suggested in the preceding article, together with suggestions for its use have been placed at the disposal of this committee, and may be obtained from the chairman, Mr. J. A. Randall, of Pratt Institute.

In the article referred to, some phases of the teaching of mechanics were discussed. The writer hopes later to submit similar suggestions for teaching the ideas of moments, work and energy, the mechanics of rotating bodies, etc. But mechanics is not the only portion of physics in which changes are needed in the method of presentation and in the equipment, and as I should like, as rapidly as possible, to make clear the very general and fundamental nature of the modifications that I am advocating, I have ventured to discuss another portion of physics in this second article. Perhaps the weakest chapters of the usual high school text in general physics, viewed in these days of electrical appliances, are those dealing with electricity and magnetism. And perhaps, also, the average laboratory equipment for these subjects is most inadequate. Physics teachers will agree, I think, that such things as tangent galvanometers, galvanoscopes, etc., are, or ought to be, relics of the past, and that the compilation of an electrostatic series, or long discussions of "one fluid" and "two fluid" battery cells represent an expenditure of time scarcely in keeping with the opportunities for really simple and valuable studies of the principles upon which modern applications of electricity are based.

Every school laboratory should be provided with a current supply which makes possible *real* experiments in electricity. And as practically every even moderately sized town nowadays is lighted by electricity, such a supply should not be a matter of great difficulty. Given this, and a reasonable number of really good ammeters and voltmeters, such as the Weston Model 45 instruments for direct current, or Model 155, and a few of the new type wattmeters if the supply system is A. C., and an indefinite number of simple and instructive exercises may be arranged. In attempting these, however, the teacher must start with *good* instruments. To purchase too cheap ammeters and voltmeters is to willfully waste money. No instruments of either type are satisfactory for school use which are not "dead beat." No voltmeter will give good results which has less than about 10 ohms resistance per volt of scale reading. There is no getting around these requirements, and cheap instruments are expensive, even as gifts, because of the valuable space they occupy.

In selecting the stock of instruments, the instructor will, of course, be guided by the laboratory plan that he regards as essential. If he is a believer in the "even front" plan by which all pupils do the same work at the same time, money may be saved by having the ammeters all millivoltmeters with external shunts. With ten millivoltmeters and four shunts each, of say 1 ampere, 2 amperes, 5 amperes and 10 amperes capacity at full instrument scale reading, a working equipment equivalent to forty self-contained instruments providing the same ranges is secured at much less cost. In such a plan, however, *all millivoltmeters should be of exactly the same* (say 45 millivolts) *drop and all shunts should be interchangeable.* The scales of the instruments should not be marked for any given value in amperes, but should be 100 division scales marked by tens. With these, intermediate readings where the full scale reading equals 1, 2, 5, etc., amperes may be quickly and closely made. Any of the manufacturers of standard instruments will meet these requirements if requested. Similarly, the voltmeters may be the same millivoltmeters with series multipliers, though *double scale instruments* of 1.5/150 or 3/150 volts are recommended as meeting all ordinary requirements and as more satisfactory. If the instructor does not insist upon the "even front" plan, ammeters with self-contained shunts, carefully selected as to the requirements of the particular experiments in which each is to be used will be found preferable.

Given, then, a proper current supply at preferably 110 volts, a reasonable number of instruments of the type just suggested, carbon lamp resistances, a supply of connecting and resistance wire, and a *live teacher,* and an interesting and "worth while" course in electricity is assured. As further suggestions of convenient forms of resistances, and of terminals which will stand the wear and tear of constant student use without loose connections or stripped threads, such as encountered where binding post terminals are used, the designs shown in Figures 5, 6, 7, and 8 are here given. Figure 5 will scarcely require further description, unless it be to call attention to the two lamps in series which make

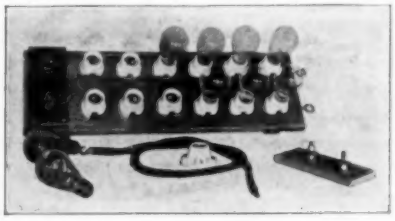


FIG. 5. A CONVENIENT FORM OF LAMP RESISTANCE.

possible changes of current by approximately ¼ ampere steps from zero to the full capacity of the lamp bank.

The carbon rheostat of Figure 6 will be found extremely convenient for a low resistance capable of change by small steps. The frame is of iron with the side rods covered by fiber tubing, and current is taken off at any point by means of the brass plate with terminal, which may be inserted between the carbon blocks

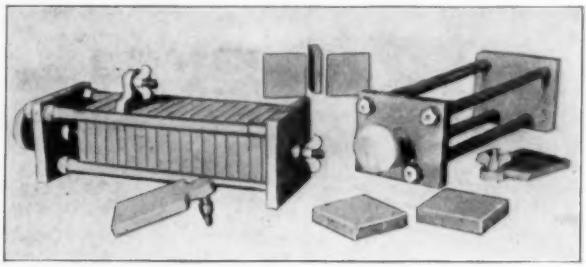


FIG. 6. AN ADJUSTABLE CARBON RHEOSTAT.

at any point. The terminals and back connected studs, for which working drawings are given in Figures 7 and 8, may be made from castings or from brass rod. The threaded rod carrying the wing nuts should consist of a 3/16 inch hardened steel set screw and the wing nuts should be bronze or brass. This construction will bring the wear where it should be—on the

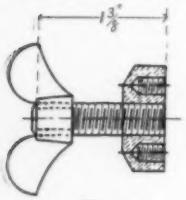


FIG. 7.

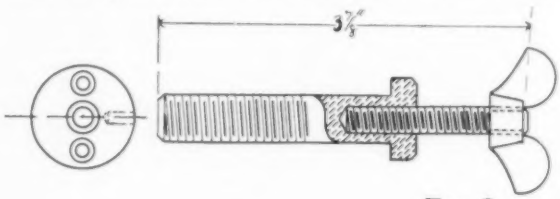


FIG. 8.

wing nut—which can be renewed as required without disturbing the soldered connections. Both set screws and wing nuts may be purchased in any sizes desired. For resistance wire, the Ia Ia wire furnished by Hermann Boker, 106 Duane Street, New York City, will be found most suitable.

GROUP II: SIMPLE MEASUREMENTS IN CURRENT, VOLTAGE, AND POWER, FOR THE ELECTRICAL LABORATORY.

(*a*) *Fall of Potential in a Conductor.*

As a first exercise with this equipment, the one commonly known under the title "Fall of Potential along a Conductor," and now given in many schools, is a selection which cannot be bettered. The exercise needs, however, in many instances, to

be broadened and made more complete, and to be removed from the "dinky" class. Fall of potential should be measured on a low reading voltmeter. The "drop" over each successive foot length of conductor with the same current should be noted, the drops over one foot, two feet, three feet, etc., of wire should be compared, and the drop over a given length of conductor with currents of 1 ampere, 2 amperes, 3 amperes, etc., should be compared, until the pupil is able to formulate definite statements of the relation of fall of potential to current and resistance.

(*b*) *Current, Voltage, and Resistance in Series and Multiple Circuits.*

A second exercise which provides most valuable ideas about series and multiple circuits, the current and voltage conditions in such circuits, the connections and use of instruments, determination of resistances by the fall of potential method, etc., is suggested by the following, which is a copy of the direction sheet furnished the student:

EXPERIMENT 43-2. CURRENT, VOLTAGE, AND RESISTANCE IN SERIES AND MULTIPLE CIRCUITS.[1]

Apparatus in the Laboratory: 110-volt direct current; three resistance coils having a low temperature coefficient.

Apparatus from the Stock Room: D.C. voltmeter; D.C. ammeter; 15-ampere fuses.

Part I. Measurement of Current:

1. Join the three coils in series, and connect them across a 110-volt D.C. circuit. Place a suitable range ammeter successively: (See *note.*)

(*a*) Between coil 1 and power.
(*b*) Between coil 1 and coil 2.
(*c*) Between coil 2 and coil 3.
(*d*) Between coil 3 and power.

Leave the ammeter in circuit for a short time in each case, and observe any fluctuation in the reading.

Record the average ammeter reading in each place. What conclusion can you draw regarding the current in a series circuit? Where should an ammeter be placed in such circuits? Include a diagram of the coils and connections in your report and indicate the (*a*), (*b*), (*c*), etc., positions of the ammeter on the diagram.

NOTE: Use a short-circuiting switch with the ammeter. Have the ammeter short-circuited when the switch to power is first closed: this will protect the ammeter if your connections are wrong.

2. Join all the coils in multiple across the 110-volt circuit, using an ammeter cut-out switch as in the note.

Take the average reading of the current with the ammeter:

[1] From Physics Laboratory Notes, Part II. Copyright 1911, by J. M. Jameson, Brooklyn, N. Y.)

(*a*) In the line between the coils and power.
(*b*) In the circuit of No. 1 alone.
(*c*) In the circuit of No. 2 alone.
(*d*) In the circuit of No. 3 alone.

Compare the sum of the currents in (*b*), (*c*), and (*d*) with the current in (*a*). Conclusion?

Where must an ammeter be placed to measure the current in a branch circuit?

Include a diagram of the coils and connections in your report and indicate the (*a*), (*b*), (*c*), etc., positions of the ammeter on the diagram.

3. Join two coils in multiple and put this multiple circuit in series with the third coil across the 110-volt circuit.

Take ammeter readings of the average current for: (*a*) each branch of the multiple circuit; (*b*) the third coil and main line. Compare the sum of the currents in (*a*) with the current in (*b*). Include a diagram of the coils and connections in your report and indicate the (*a*) and (*b*) positions of the ammeter on the diagram.

Part II. Measurement of Voltage:

1. Connect the coils all in series across 110 volts, and with a suitable voltmeter take the drop across:

(*a*) All three coils.
(*b*) Each coil alone.

Leave the voltmeter connected for a short time in each case and observe any fluctuation in its reading. Record the average drop.

Compare the sum in (*b*) with the reading in (*a*). What conclusion can you draw regarding the voltage in a series circuit?

With a constant potential of 115 volts at the power switch, what will be the effect upon the current flowing through each unit if the resistance of any unit is decreased?

Include a diagram of the circuit in your report and indicate the (*a*) and (*b*) positions of the voltmeter on the diagram.

2. Connect the three coils in multiple, and take the drop between the bind posts of each coil. Compare these readings.

Assuming a constant voltage of 115 volts at the power switch, would a loose connection in any branch affect the drop across the multiple group? If so, how? Would it affect the line current? If so, how? What will be the effect upon the drop across the group if the resistance of any unit is decreased? Upon the current through that unit? Through each of the other two units? In the line?

Part III. Computation of Resistance from Ammeter and Voltmeter Readings:

From your readings in Part I and Part II, compute:

(*a*) The resistance of each coil.
(*b*) The joint resistance of all three in multiple.

Compare the value obtained in (*b*) with the value of the joint resistance computed from the separate resistances of the coils by the usual method.

The above exercise, which as here given is rather long, may be broken up into separate short exercises, or in other ways shortened to meet the requirements of the laboratory schedule. The coils which are recommended are shown in Figure 9. These are made of double cotton covered Ia Ia wire wound on two inch iron pipe. A covering of *thin* asbestos sheet over the pipe

before the wire is wound on prevents short circuits between the coils and pipe. Only one layer of wire should be wound on the pipe if possible, and both ends of the pipe should be left open. This construction provides for cooling through free contact with the air. Coils of about 60 ohms, 80 ohms, and 100 ohms (preferably not in these exact simple ratios) will be found desirable. These may be connected in series or individually across 110 V power mains without excessive heating, and as the temperature coefficient of Ia Ia wire is negligible, the resistance will not change appreciably with change of temperature.

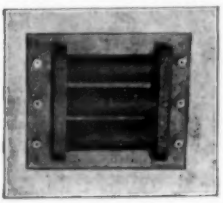


FIG. 9. RESISTANCE COILS FOR SERIES AND MULTIPLE CONNECTIONS ACROSS 110 V.

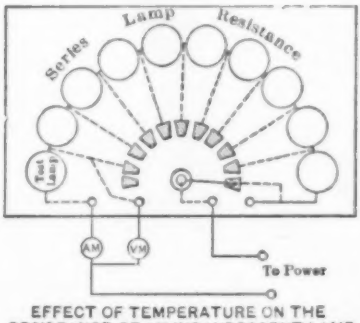
(*c*) *Current and Resistance for Incandescent Lamp Filaments at Different Temperatures.*

The data and curves for this exercise furnish very interesting and instructive comparisons between the electrical properties of carbon and metallic filament lamps, especially as to their respective change in resistance due to change in temperature. The series lamp bank used has the lamp sockets mounted on a slate base, with a dial contact maker for cutting lamps into or out of circuit. The procedure of the exercise, readings required, computation, etc., will be understood from the suggested direction sheet for the student.

EXPERIMENT 43-6. THE EFFECT OF TEMPERATURE ON THE RESISTANCE OF A LAMP FILAMENT.[1]

Apparatus in the Laboratory: 110-volt direct current; series lamp resistance.

Apparatus from the Stock Room: 6-ampere fuses; lamps to be tested. These should be of several types.



EFFECT OF TEMPERATURE ON THE RESISTANCE OF AN INCANDESCENT LAMP

Connect your apparatus with the 110-volt circuit as shown in the diagram, using first a carbon filament test lamp. (The voltmeter is here connected around the ammeter so that the latter may read the true current through the lamp.) Put a fuse in the line to protect the ammeter.

Take readings of both voltmeter and ammeter with all the lamps in the lamp board in series with test lamp. Then cut out one lamp at a time.

[1]See foot note page 331.

and take readings of the voltmeter and the ammeter for each step until the last reading is for the test lamp alone. The ammeter and voltmeter should be read simultaneously.

Compute the resistance of the test lamp for each current.

You have no actual measurement of temperature here, but as the current increases the temperature of course rises—very perceptibly for the last two or three readings.

Plot a curve from your data, using the resistance of the lamp as ordinates, the current as abscissae.

What conclusion may be drawn regarding the effect of increase of temperature on the resistance of the filament?

Test in the same way lamps having a treated carbon filament, and lamps having a metal filament as in the tantalum and tungsten lamps. Plot curves for each and compare the filaments as to their change in resistance with rise in temperature.

Problem: Measure on a Wheatstone bridge, the resistance of the tungsten filament lamp at room temperature (20° C.). Using the temperature coefficient of tungsten as .0051, compute the temperature of the filament when used at full candle power on rated voltage.

(d) Study of a Model of an Incandescent Lighting System.

A most interesting and valuable laboratory exercise is furnished by a study of the current, voltage, and power distribution in an incandescent lighting system, and a determination of the transmission losses. The model of a two-wire system, used for this purpose at Pratt Institute, is shown in Figure 10. The feeders and lamp clusters are here mounted upon a frame 6x8 feet in size, which also supports a shelf upon which the necessary instruments may be assembled. On the back of this frame (not shown in the cut) is mounted a similar three-wire distributing system. This frame was designed to economize space in the laboratory, and because there was no available wall space upon which the wire could be run. For the same reason, number 14 German silver wires, with standard rubber core and braid insulation, are used for feeders. Because of their higher resistance, these give in the comparatively short lengths between lamp clusters a fall of potential which is comparable with that which would exist in a regulation line between

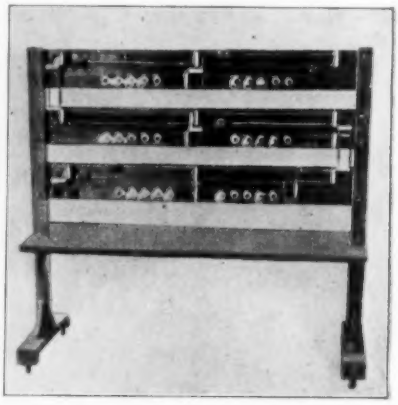


FIG. 10. MODEL OF AN INCANDESCENT LIGHTING CIRCUIT.

the first and second, second and third, etc., floors of a building. Where there is room in the laboratory, long copper feeders and a different arrangement of the system might be used to advantage. At the beginning of the exercise, the instructor specifies the number and type of lamps to be used at each cluster. By varying the number of lamps at the various groups, using 32 candle power lamps, metallic filament lamps, etc., each group of students may be provided with a special problem. The power switch which supplies the system is regarded as the generator. A suggested form of direction sheet for the student is here given to show the data that the student may be expected to take and the computation involved. These directions are for a D. C. system. A similar procedure may be followed with an A. C. system.

Experiment 45-1. The Measurement of the Current, Voltage, and Power of a Model Lighting Circuit. Two-Wire System.[1]

Apparatus in the Laboratory: Model lighting circuit board; 110-volt direct current.

Apparatus from the Stock Room: Ammeter; voltmeter; yard stick; 15-ampere fuses.

The line wires are No. 14 German silver, resistance 180 ohms per mil-foot, to furnish in the short space of the laboratory, conditions similar to those of an actual incandescent lighting circuit.

Get directions from an Instructor regarding the number of lamps to be used in the line, and their arrangement. Record all readings of current, voltage, etc., on a single outline diagram of the line.

The switch at the end of the line is to be regarded as the source of power. Measure the voltage at this switch and the current in each section of the line *at this voltage.*

Measure the distance from the switch to the first group of lamps, also the distance from each group to the next succeeding group. (Measure in each case to the point on the mains at which the short leads from the lamps are attached. The resistance of the short copper leads to the lamps may be neglected.)

From its length and mil-foot resistance, compute the resistance of each section of the line. Compute also the "drop" over each section, and the voltage at each group of lamps. Check your computed voltage by comparison with the voltmeter readings across the lamps. *As the supply voltage may fluctuate, one voltmeter should be kept connected across the supply switch, and the voltage at the lamps should be read from a second voltmeter when the voltage at the switch is at the proper value.*

From your data determine also:

1. The watts delivered at the power switch.
2. The watts expended in each section of the feed wires.
3. The watts expended in each group of lamps.
4. The total watts supplied to the lamps, and the total line loss.
5. The "efficiency" of the line—i.e., per cent of the total power supplied which is delivered to the lamps.
6. The resistance of each group of lamps and the average hot resistance of a single lamp.

Show all computations in your report.

[1]See foot note page 331.

PROBLEM DEPARTMENT.

By E. L. Brown,
Principal North Side High School, Denver Colo.

Readers of this magazine are invited to send solutions of the problems in which they are interested. Problems and solutions will be duly credited to their authors. Address all communications to E. L. Brown, 3435 Alcott Street, Denver, Colo.

Algebra.

276. Example 55, page 118, Hawkes' Advanced Algebra.

Solve: $$\frac{x-1}{y-1} = \frac{a-1}{b-1}, \qquad (1)$$

$$\frac{x^3-1}{y^3-1} = \frac{a^3-1}{b^3-1}. \qquad (2)$$

Solution by T. E. Peters, Denton, Texas, and Nelson L. Roray, Metuchen, N. J.

Dividing (2) by (1) we have

$$\frac{x^2+x+1}{y^2+y+1} = \frac{a^2+a+1}{b^2+b+1}. \qquad (3)$$

From (1) $x = \left(\frac{a-1}{b-1}\right) y + \frac{b-a}{b-1}$.

Substitute in (3), we obtain

$$y^2 - \left[\frac{b(1-ab)+b^2-a}{1-ab}\right] y + \frac{b(b^2-a)}{1-ab} = 0 \qquad (4)$$

Solving (4) as a quadratic we find

$$y = b \text{ or } \frac{b^2-a}{1-ab}. \quad \text{Hence, } x = a \text{ or } \frac{a^2-b}{1-ab}.$$

By inspection we see at once that $x=a$ and $y=b$. Hence, the other value of y is found by dividing the absolute term of (4) by b, giving $\frac{b^2-a}{1-ab}$.

The other value of x and of y is infinity.

277. *Proposed by E. A. Cummings, Denver, Colo.*

Five balls are in a bag, and it is not known how many of these are white; two being drawn are both white. Find the probability that all are white.

Solution by I. L. Winckler, Cleveland, Ohio.

We may make four hypotheses: (1) all five balls are white; (2) four white and one black; (3) three white and two black; (4) two white and three black.

The probability of drawing 2 white on the first hypothesis is 1, on the second is $\frac{2}{5}$, on the third is .3, on the fourth is .1.

Therefore the probability of the first hypothesis being true is

$$1 \div (1 + \tfrac{2}{5} + \tfrac{3}{10} + \tfrac{1}{10}) = \tfrac{1}{2}.$$

Geometry.

273. *Proposed by H. H. Seidell, St. Louis, Mo.*

The chord of a segment is 10 feet and the radius of the circle is 16 feet. Find the area of the segment.

I. *Solution by T. M. Blakslee, Ames, Iowa, and A. M. Harding, Fayetteville, Ark.*

Area of segment $= 2(\frac{1}{2}r^2\theta) - 5\sqrt{231}$, where $\theta = \frac{1}{2}$ the angle subtended at center by segment, and where $\sqrt{231}$ = length of perpendicular from center to chord.

$\therefore$ Area $= 16^2 \cdot \sin^{-1}\left(\frac{5}{16}\right) - 5\sqrt{231} = 5.37$ sq. ft.

II. *Solution by R. E. Bowman, Alliance, O., and C. A. Perrigo, Dodge, Neb.*

Let A = area of segment, c = length of chord, and h = height of segment.

Then $A = \frac{2}{3}ch + \frac{h^3}{2c} = \frac{2}{3} \times 10 \times \frac{8}{10} + (\frac{8}{10})^3/20 = 5.37$ sq. ft.

III. *Solution by Nelson L. Roray, Metuchen, N. J.*

By Huyghens' Formula the approximate length of the arc of this chord is $\frac{8B-A}{3}$, where A is chord of arc and B is chord of one-half the arc.

Since A=10 and R=16, $\therefore$ B=$4(\sqrt{21}-\sqrt{11})$.

$\therefore$ Arc of A= $\frac{32(\sqrt{21}-\sqrt{11})-10}{3}$.

$\therefore$ Area of sector $= \frac{8}{3}[32(\sqrt{21}-\sqrt{11})-10]$.

Area of triangle $= 5\sqrt{231}$.

$\therefore$ Area of segment $= \frac{256}{3}(\sqrt{21}-\sqrt{11}) - \frac{80}{3} - 5\sqrt{231} = 5.37$ sq. ft.

Remark by Editor.

From elementary geometry we have $a = [r(2r - \sqrt{4r^2-b^2})]^{\frac{1}{2}}$, where r=radius of circle, b chord of any arc and a chord of one-half the same arc. By repeated use of this formula the approximate length of arc subtended by b may be found. Then solve as in III above.

279. *Proposed by Olaf K. Lie, Richmond, Mass.*

In a sphere is inscribed a cone whose volume is one-fourth the volume of the sphere. Find the altitude and the radius of the base of the cone.

I. *Solution by A. M. Harding, Fayetteville, Ark., and H. A. Porter, Liberty Hill, Tex.*

Let R=radius of sphere, h=altitude of cone and r=radius of its base.

Then $r = [R^2 - (h-R)^2]^{\frac{1}{2}} = [2hR - R^2]^{\frac{1}{2}}$.

Also $\frac{1}{3}\pi hr^2 = \frac{1}{4}(\frac{4}{3}\pi R^3)$ or $hr^2 = R^3$.

$\therefore$ $h(2hR - h^2) = R^3$.

$\therefore$ $h^3 - 2h^2R + R^3 = (h-R)(h^2 - hR - R^2) = 0$.

$\therefore$ $h = R$ or $\frac{R}{2}(\sqrt{5}+1)$.

Then $r = R$ or $\frac{R}{2}[2\sqrt{5}-2]^{\frac{1}{2}}$.

II. *Solution by Nelson L. Roray, Metuchen, N. J.*

Given sphere O with inscribed cone ABC whose volume is ¼ of volume of sphere or $\frac{\pi R^3}{3}$. To find altitude and radius of base of cone.

Solution for a right cone. Let the perpendicular OD from the center of the sphere to the base of the cone be x, then altitude AD of cone is $R + x$. Then BD radius of base of cone is $\sqrt{R^2 - x^2}$.

Vol. of cone is $\pi \cdot \frac{R+x}{3}(R^2-x^2)$.

$$\therefore \frac{\pi}{3}(R+x)(R^2-x^2)=\frac{\pi R^3}{3}.$$

$$\therefore x^3+x^2R-R^2x=0.$$

$$\therefore x=0, \text{ or } -\frac{R+R\sqrt{5}}{2}.$$

That is the altitude of the cone is equal to the radius of the sphere and the radius of its base is the radius of the sphere, that is, its base is a great circle of the sphere. The altitude is $\frac{R+R\sqrt{5}}{2}$ and radius of base $\frac{R}{2}\sqrt{2\sqrt{5}-2}$.

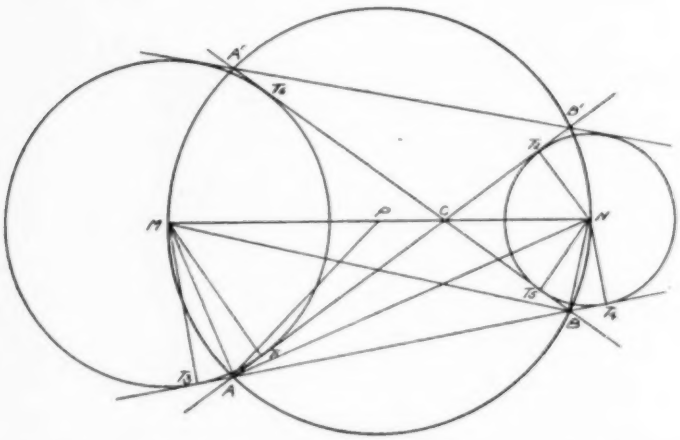
In the latter case the perpendicular sect from the center of the sphere to the base of the cone is equal to a side of the regular decagon inscribed in a great circle of the sphere, and the altitude of the cone is double the apothem of the regular inscribed pentagon.

280. *Selected.*

Prove that the circumcircle of the triangle formed by any three of the four common tangents to two circles passes through the mid-point of the line joining their centers.

I. *Solution by G. Sergent, San Mateo, Cal.*

Let ABC be the triangle formed by the three tangents T_1T_2, T_2T_4, T_3T_4. The right triangles MT_1A and MT_2A are equal; likewise the right triangles NT_2A and NT_4A. $\therefore$ MA and NA are the bisectors of the supplementary angles T_2AT_3 and T_2AT_4, respectively, and are perpendicular to each other. The angle MAN being a right angle, A is on the circle P described on MN as a diameter.



Similarly it can be proved that MB and NB are perpendicular and that B lies on the same circle; likewise A′ and B′.

In circle P the ∠APM is measured by arc AM, *i. e.* ½ arc AA′, the arcs AM and A′M being equal by symmetry. In the same circle ∠ABC is measured by ½ arc AA′ $\therefore$ ∠APM = ∠ABC, and consequently ABC and APC are supplementary. Hence the quadrilateral ABCP is in-

scriptible, that is the circumcircle of ABC passes through P, the mid-point of MN.

In a similar manner the proposition can be proved for a triangle formed by the two external and one internal tangent.

II. *Solution by R. M. Mathews, Chicago, Ill.*

The circumcircle of the triangle formed by any three of the four common tangents to two circles passes through the mid-point of the line joining their centers.

We know that in any triangle the vertices are concyclic with the mid-points of the lines joining the incenter and excenters two by two. Consider the set of four common tangents of two circles. For either triangle formed by tangents two direct and one transverse the smaller triangle is in-circle the other an ex-circle; for either triangle formed by tangents, two transverse and one direct, the circles are ex-circles. Hence, in any case, the cirumcircle of any triangle formed by three of the four common tangents of two circles passes through the mid-point of the line joining their centers.

Trigonometry.

281. *Proposed by Franklin T. Jones, Cleveland, Ohio.*

In a right spherical triangle, the sum of two legs, a and b, is 180°, and the sum of the opposite angles A and B, is also 180°. If in such a triangle A=5°, find the lengths of the sides. (From an entrance examination paper of Harvard University).

I. *Solution by A. C. Smith, Denver, Colo., and T. M. Blakslee, Ames, Iowa.*

$\text{Cos } A = \cos a \sin B$

$\text{Sin } B = \sin A$, since $A + B = 180°$.

$\therefore \text{Cos } A = \cos a \sin A$

$\therefore \cos a = \cot A = \cot 5° > 1$, which is absurd.

Hence the triangle is impossible.

II. *Solution by I. L. Winckler, Cleveland, Ohio.*

The spherical triangle given is impossible. Suppose a', b', c' the sides of the polar triangle of the given triangle. Then $a' < b' + c'$.

$\therefore$ in the given triangle $\pi - A < \pi - B + \pi - C$, and since $C = \frac{\pi}{2}$

this reduces to $B < \frac{\pi}{2} + A$ .....(1)

In the triangle as given $A = 5°$. $\therefore$ since $A + B = 180°$, $B = 175°$. By (1) $B < 95°$ in order that the triangle be possible.

In the case where the two angles of a right spherical triangle are given the other parts are determined without ambiguity, but there are certain limitations in order to insure a possible triangle.

(1) If $A < \frac{\pi}{2}$ then $B > \frac{\pi}{2} - A$ and $B < \frac{\pi}{2} + A$

(2) If $A > \frac{\pi}{2}$ then $B > A - \frac{\pi}{2}$ and $B < \frac{3\pi}{2} - A$

CREDIT FOR SOLUTIONS RECEIVED.

270. R. M. Mathews. (1)
273. R. M. Mathews. (1)
274. R. M. Mathews. (1)

276. A. M. Harding, T. E. Peters, H. A. Porter, Nelson L. Roray, Jacob P. Sauter. (5)
277. H. G. McCann, I. L. Winckler. (2)
278. T. M. Blakslee, R. E. Bowman, (2 solutions) A. M. Harding, C. A. Perrigo (2 solutions), Nelson L. Roray, Donald C. Steele, (8)
279. T. M. Blakslee, R. E. Bowman, A. M. Harding, R. M. Mathews, H. G. McCann, H. A. Porter, Gertrude L. Roper, Nelson L. Roray, I. L. Winckler. (9)
280. A. M. Harding, R. M. Mathews, Nelson L. Roray, G. Sergent. (4)
281. T. M. Blakslee, Nelson L. Roray, A. C. Smith, I. L. Winckler. (4)

Total number of solutions, 35.

PROBLEMS FOR SOLUTION.

Algebra.

292. *Selected.*

$2x^4 - 4x^3 + Kx^2 + 41x - 30 = 0$ has the sum of three of its roots equal to zero. Find all the roots.

293. *Proposed by E. B. Escott, Ann Arbor, Mich.*

Solve $(a^2 - b^2)\ x^2 = 4b^2\ (x^2 + 1)\ (x^2 - x + 1)$

Geometry.

294. *Proposed by A. C. Smith, Denver, Colo.*

If s be the semiperimeter of a triangle, r_1, r_2, r_3 the radii of its escribed circles prove that

$$s^2 = r_1r_2 + r_2r_3 + r_3r_1.$$

295. *Proposed by I. N. Warner, Plattesville, Wis.*

If from any point A on a circle the chords AB, AC are drawn so as to trisect the area of circle, find angle between the chords.

296. *Proposed by Nelson L. Roray, Metuchen, N. J.*

If O, O′ be any isogonal conjugate points, with respect to the triangle ABC, and if OL, O′L′ be perpendicular to BC; OM, O′M′ perpendicular to AC; and ON, O′N′ perpendicular to AB; show that the six points L, M, N, L′, M′, N′, are concyclic with mid-point of OO′ and that MN is perpendicular to AO′. (Lachlan's Modern Pure Geometry, p. 56, ex. 2.)

NOTICE.—Mr. A. C. Smith, Denver, Colo., has called our attention to the fact that in solution I of Problem 259, p. 150, February number, the equation $8x^4 - 23x^2 - 4 = 0$ does not follow from the preceding equation. Hence the solution is incorrect.

SCIENCE QUESTIONS.

By Franklin T. Jones,
University School, Cleveland, Ohio.

Our readers are invited to propose questions for solution—scientific or pedagogical—and to answer the questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.

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Open Book Tests.

By A. P. Andrews,
Minneapolis, Minn.

In preparing an open book test the underlying thought must be how to arrive at a knowledge of the students' understanding of a subject. The nature of the test naturally excludes questions which involve ONLY the exercise of memory, and also any questions the answers to which may be copied directly from the text. These considerations have given rise to the criticisms that the open book method of conducting tests greatly limits the number of questions that it is possible to ask, in fact makes it practically impossible to cover certain portions of the text with questions that would be worth while under this plan. The suggestion has even been offered that such a test would have to consist of problems exclusively.

While there is truth in these statements, there are, nevertheless, enough questions available to make it very much worth while to give a test of this kind. Perhaps a few illustrations may serve to show how the work of making the questions is approached. As a first example take the matter of electrical capacity. In place of asking for the definition, this simple problem is set: If it takes 15 units of charge to raise the potential of an uncharged condenser to two volts, what is its capacity? An answer to this question will give the teacher a line on the students' knowledge of capacity which the mere statement of a definition could never do. This particular question has the further merit that it can be quickly answered and almost instantly rated. Another type of question may be illustrated from the subject of magnetism. In a certain article of our text (Millikan and Gale) there is described a number of experiments upon which is based the theory of the molecular nature of magnetism. A question bearing on this paragraph and having a practical application is: Taking into consideration the experiments described in article 315, what are some precautions that should be observed to prevent a magnet from losing its magnetism? Sometimes the students are asked to make (for someone else to solve) a simple problem that shall involve no other quantities than

those directly concerned in some designated law or principle. Then there is a type of question which may test a student's grasp of a subject as a whole. For example: State and discuss the kinetic theory of gases devoting not more than eighty words to it. The main point in limiting the discussion is to measure the student's ability to select the essential facts—and incidentally to protect the teacher from "blanket" answers. Then, too, the teacher must remember that many questions that to him would seem ridiciously simple with the open book are not so to many of the students. I often put into my tests a very simple and easy question, for example, one like this: What was the purpose of Joule's numerous experiments in heat? This has not much value for perhaps the majority of the class but it often serves the purpose of helping the teacher to find the WEAKEST students. Of course a question of this character should not be rated equally with other more important ones.

From considerations like the above it should not be so difficult to make one or more sets of questions that would fairly cover any subject in physics. To test whether there really was any shortage in materials suitable for open-book examinations, I recently took my file of SCHOOL SCIENCE AND MATHEMATICS and going through the Science Question department of every number, wrote down such questions and problems as I would be willing to submit to my classes. To my surprise I came away with a list of fifty-six.

As a closing remark I would like to call attention to a danger that is likely to be encountered in classes which are given open-book tests. The point is that in placing so much emphasis on the understanding, the importance of the memory may be underestimated. Memory has its place in science teaching as well as in every other subject, and while the open-book system does place the emphasis on the comprehension it need not do so at the expense of memory development. As one correspondent has pointed out to me, great care must be taken in this regard especially with beginners whose only means of getting the significance of the technical terms encountered in beginning the study of any new science is by an effort of the memory. The remedy for such a tendency would seem to be the simple one of insisting on the proper exercise of the memory on such portions of the text to which it should be rightly applied. Occasionally taking five or ten minutes from a recitation for conducting a PURELY MEMORY TEST will prove a very effective check.

The above remarks as well as the questions that follow are submitted in the hope of drawing such suggestions and criticisms as may enable the writer to strengthen his methods of testing, as well by valuable additions as by the elimination of faults.

Answer serially numbered questions.

MAGNETISM AND STATIC ELECTRICITY.

Answer all questions. Time: One hour.

1. Using a magnetic needle as a means of testing, why is repulsion of the needle the only sure test as to whether a bar of iron is magnetized or not?

2. Explain clearly how the keeper on a horseshoe magnet serves its purpose of preserving the strength of the magnet.

72. An N magnetic pole of strength 24 units is 8 cm. from an S pole having 4 units of strength. With how much force do they attract each other? Name the unit.

4. What besides observing the direction in which a compass needle points is it necessary to know in order to determine the true geographic north and south direction at a place?

5. When a body is charged permanently by induction it always receives a charge (like, unlike) the inducing charge. Strike out the wrong word and explain.

6. A is an insulated conductor and B is an electroscope charged positively. A proof plane is touched to A and then applied to B, the electroscope, the leaves of which are observed to come together. What does this convergence of the leaves tell as to the electrical condition of A?

73. If it takes 90/300 of an erg of work to carry two units of charge from one charged body to another, what is the P. D. of the bodies?

74. The capacity of an electrical condenser is 15 units. What is its potential when it holds 225 units?

CURRENT ELECTRICITY.

Answer all questions. Time: One hour.

1. Draw a diagram of a D'Arsonval galvanometer indicating accurately the position of the coil with reference to the magnet when properly set up ready for use. Why does the coil turn when a current is sent through it?

2. A magnetic needle is held under a trolley wire in which the current runs east to west. Which way will the N pole turn? Why?

3. Upon what does specific resistance depend?

4. What is the essential difference between a primary cell and a secondary cell?

75. A certain length of wire has a resistance of 10 ohms and a diameter of .08 mm. What is the resistance of another wire of the same material and length but having a diameter of .32 mm?

76. Calculate the current strength in the circuit shown in Fig. 1. The E. M. F. of each cell = 1.5 volts, the resistance of each cell = 0.5 ohm, the resistance of each coil = 15 ohms, and the resistance of the connecting wires is negligible.

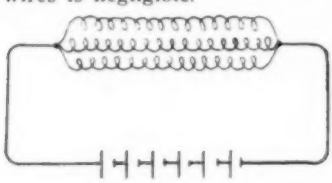

FIG. 1

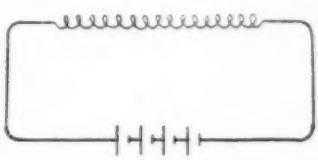

FIG. 2

7. Make another diagram showing how to connect into the circuit of Fig. 2 an ammeter and a voltmeter so as to show at the same time both the current and the fall of potential through the resistance AB.

MEMORY TEST IN MAGNETISM.

Questions stated orally. Time: Eight minutes.

1. Name four properties of magnets.
2. State two laws of magnets.
3. Define a magnetic pole of unit strength.
4. How is the strength of a magnetic field measured?
5. Name three things that must be included in a statement of the theory of magnetism.
6. Define declination and inclination.

THE NEW HARVARD CATALOGUE.

At first glance the book seems unnecessarily big, but on closer examination one realizes that a list of some 700 instructors and 4,500 students, a description of 900 courses and of more than 400 scholarships, and the announcements of a college and seven professional schools must necessarily occupy considerable space.

Comparing the book with its predecessor, some interesting differences appear. The number of instructors has increased from 634 to 707, the freshman list includes 68 more names or a total of 739, and the scholarships available in the college alone amount to a total of $50,000, as compared with $48,000 a year ago.

Professor George Herbert Palmer, sole survivor of the six tutors appointed in the first year of President Eliot's administration, heads the list of professors giving instruction.

The list of more than 300 colleges and universities from which students come to enter the Harvard graduate schools indicates the cosmopolitan character of the institution, but perhaps this is brought out most forcibly in the list of students' home addresses, where one may find representatives from India, China, Japan, Siam, Persia, Turkey, Germany, England, and France, and from practically every state in the Union besides.

Most welcome, probably, to the boy who lives at a distance from Cambridge will be the information which the catalogue gives concerning the new plan of admission.

The old plan undertook to scrutinize the character of the work in every high school subject; and to that end dictated the precise topics of high school study and the exact method of teaching them. The new one says to the high school: "Give your boy the best academic education you know how, list any order of studies and methods of instruction you think best; then send him up, and the college will sample his quality by examinations and find out what you have made of him." For this purpose four examinations are believed to be enough.

The school that does not feel able to follow the college-planned curriculum can now, for the first time, fit boys for Harvard and meet at the same time the needs of the local community, and the boy who does creditable work in an unusual course of study is given an opportunity to enter the country's oldest university.

VACCINATION FOR TYPHOID FEVER.

Typhoid vaccination, at first a voluntary measure in our army, has since July 1, 1911, been made compulsory for all officers and enlisted men below the age of 45 years and who have not had an authenticated case of typhoid fever.

The immunization of the army has proceeded rapidly until, at the present time, somewhat over 60,000 men have completed the necessary three inoculations. Among this entire number, and covering a period of nearly three years, but twelve cases of typhoid have developed and no death has occurred. One man at the Guantanamo Naval Station died five days after the first inoculation from a case of walking typhoid. This is the only fatal case of typhoid in the government service in anyone on whom the inoculation had been begun. The record of the Maneuver Division in camp at San Antonio, Tex., during the past summer has been most instructive. An army division having an average strength of 12,800 men, all inoculated, occupied the same camp for four months, from March

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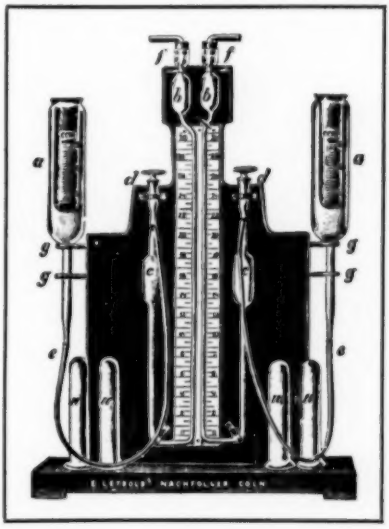

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to July, and in this command but one case of typhoid developed. This was a mild case in a hospital corps man who had not completed the inoculations necessary for protection. There were forty-nine cases of typhoid with nineteen deaths in the city of San Antonio for the same four months. During the same period that this camp existed at San Antonio, between three and four thousand men were in camp at Galveston, Tex., and in this command no case of typhoid occurred, while the city of Galveston furnished 192 cases of the disease during the existence of the camp. The city and the camp had the same water, milk, and food-supply, the only difference being that the camp had been protected by inoculation.

About 3,000 men were scattered along the Mexican border mostly in small camps, many of them in localities where typhoid was present, yet of this command only one man contracted typhoid, which ended in recovery. In a recent number of the *Journal of the American Medical Association*, Captain Phelan, of the Medical Corps of the Army, contrasts the record of these camps with those of the concentration camps of the Spanish-American War, and says that it is inconceivable that, with such conditions, the practical abolition of typhoid could have been effected without the use of inoculations.

THE UNDERVALUED BANANA.

The dictum that fruits should be eaten "in their season" finds its limitations as regards variety in the temperate zones at certain periods of the year. There is, however, one fruit which is readily available fresh in American markets at practically all seasons, although it grows best from November to April in its tropical or semitropical home. It is unfortunate that an article of diet which meets certain nutritive requirements so well and is so easily obtained at reasonable cost as the banana should be the subject of much misunderstanding among both physicians and laymen. For despite the fact that over forty million bunches are reported to have been brought to the United States last year, it is popularly stated in many quarters that the banana is difficult of digestion and may give rise to alimentary distress.

A closer consideration of the composition of the banana may serve to elucidate the situation. The fruit is brought to our Northern markets green, and is ripened by artificial heat. This process can be hastened or delayed within certain limits according to the momentary demands of the retail trade. The color of the peel gives evidence of the degree of ripeness. The green banana contains, in the part exclusive of the skin, about 1.5 per cent of the protein and 20 to 25 per cent of carbohydrate, almost entirely starch. In the ripe banana, with yellow-brown peel, the edible part contains somewhat less (16 to 19 per cent) of carbohydrate; but that which remains is now almost entirely in the form of soluble sugars. Broadly speaking then, the ripe banana is about one-fifth sugar; the green, one-fifth starch. Most of the remainder of the edible pulp is water. Intermediate degrees of ripeness present starch and sugar in reciprocal proportions varying between the limits set above.

Inasmuch as bananas are commonly eaten uncooked, it is obvious that more or less raw starch will be ingested if the fruit is not ripe, i. e., if the skin has not begun to shrivel and darken. Raw starch may be singularly irritating to the alimentary tract of man and is at best poorly utilized, whether it be ingested in the form of uncooked potatoes, chestnuts, bananas or other native starchy foods. No one would advise the use of

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uncooked potatoes; yet many people eschew a thoroughly ripe banana in the belief that this wholesome fruit is "rotten" when the skin becomes darkened, whereas they eagerly eat the yellow-green starch-bearing fruit at a stage of incomplete ripeness. "Green" bananas, like "green" apples, are unwholesome so long as the starch has not been adequately converted into sugars in the ripening process. But the delicious and innocuous ripe banana should not be made to suffer in its dietetic reputation because of the ignorance of the consumer. Here is a chance for popular education, says the *Journal of the American Medical Association* in a recent editorial.

BOOKS RECEIVED.

Physiography for High Schools, by Albert L. Arey, Frank L. Bryant, William W. Clendennis and William T. Mourey of the New York City High Schools. Pages vi+450. 14x21 cm. Cloth, 1912. D. C. Heath & Company, Boston.

Theoretical and Physical Chemistry, by S. Lawrence Bigelow, University of Michigan. xiii+544 pages. 15x22 cm. Cloth, 1912. The Century Co., New York.

Laboratory Problems in Physics, by Franklin T. Jones, University School, Cleveland, and Robert R. Tatnall, Northwestern University, Evanston, Ill. Pages ix+81. 11x19 cm. Cloth, 1912. 50 cents net. The Macmillan Company, New York.

The N. E. A. Phonetic Alphabet, by Raymond Weeks, James W. Bright and Charles H. Grundgent. 91 pages. 13x19 cm. Paper, 1912. New Era Printing Co., Lancaster, Pa.

A Guide for the Study of Animals, by Worrallo Whitney, Frederic C. Lucas, Harold B. Shinn and Mabel E. Smallwood, of the Chicago City High Schools. Pages ix+197. 13x19 cm. Cloth, 1911. D. C. Heath & Co., Boston.

Principles of Human Nutrition, by Whitman H. Jordan, New York Experiment Station. Pages xxi+450. 14x20 cm. Cloth, 1912. $1.75 net. The Macmillan Company, New York.

Proceedings and Addresses of the Forty-ninth Meeting of the National Education Association. Pages xvi+172. 17x24 cm. Cloth, 1911. Winona, Minn.

Free Will and Human Responsibility, by Herman H. Horne, New York University. Pages xvi+197. 13x20 cm. Cloth, 1912. $1.50 net. The Macmillan Company, New York.

All the Children of All the People, by William H. Smith, Pages viii+346. 13x19 cm. Cloth, 1912. $1.50 net. The Macmillan Company, New York.

Outlines of Applied Optics, by P. G. Nalting, Bureau of Standards. Pages ix+230. 14x19 cm. Cloth, 1912. $2.00 net. P. Blakeston's Son & Co., Philadelphia.

Annual Edgar County, Ill., Public Schools for 1911-12. George W. Brown, Paris. 148 pages. 15x23 cm. Paper.

ERRATUM.

On page 16 of the January number, fourth line from the top, the sentence beginning, "The cord," etc., should read: The cord supporting the weight should be so adjusted that the weight at the top will be within a few inches of the pulley when the other weight is on the floor.

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BOOK REVIEWS.

A Leaf Key to the Genera of the Common Wild and Cultivated Deciduous Trees of New Jersey, by Mary F. Barrett. Pp. 7, 10 cents. Published by the author, Upper Montclair, N. J.

This is an artificial key to the genera. There are no descriptions. The identification would need to be checked up by examination of the description of the genus in some manual. Since most manuals are supplied with artificial keys to families and genera the field of this pamphlet does not seem to be large. Its small cost might recommend it in those cases where identification must be done with an inadequate supply of manuals.

W. L. E.

Commercial Geography. By Albert Perry Brigham. 28 chapters, 449 pages, 17 colored maps, and 253 illustrations. 1911. $1.30. Ginn and Company, Boston, Mass.

This latest addition to the texts of commercial geography will very rapidly prove its worth because of the practical pedagogic principles followed in the arrangement and presentation of the material.

The great raw materials of world-wide interest and of the vast significance in the commercial world are concretely presented, as Part I, in a series of chapters on wheat, cotton, cattle, iron, and coal. A study of the activities centered about each of these great raw materials gives the student a broad outlook and furnishes a basis for Chapter VI on the Principles of Commercial Geography. The discussion of raw materials before the considerations of the geographic principles will be welcomed by educators as far superior to the usual broad generalizations concerning a conglomerate hodgepodge of land forms, climate, rivers, lakes, raw materials, transportations and industry. Chapter IV on Iron is typical of the method in which this text presents all of the five great raw materials. This chapter has excellent views, diagrams, maps, and graphs.

The five types of raw materials are followed by the discussion and application of the principles to the United States which forms Part II of the text. This presents in eleven chapters the physical features: plant, animal, and mineral features; water resources; transportation; commerce; centers of general industry and the concentration of industries. The space given to the United States is more than the average text but this added emphasis is in accord with the general movement among educators to require from students a better understanding of our own country. The maps of production are especially clear and are constructed so that a comparison of various states and regions is easy. The water resources of the United States is a chapter not generally considered in a commercial geography but it makes a most valuable addition. The concentration of industries and the centers of general industry is another innovation which is most heartily endorsed by instructors as excellent material well designed for instruction in modern commercial geography.

The foreign countries receive a brief but ample discussion for high school students. In each of the countries the proper emphasis is given the predominant industry of each individual country. The final chapter on World's Commerce is an excellent application of the geographic principles which have been developed in the previous sections of the text.

In the writer's opinion this text has many points of superiority which greatly strengthen the instruction in commercial geography.

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A Text-Book of Botany, by Coulter, Barnes & Cowles, Vol. II, Ecology, by Dr. Cowles. Pp. 485-964. American Book Company. 1911.

The second volume of the Coulter, Barnes & Cowles text-book is unique in that it is the only comprehensive book in its field. A great quantity of ecological facts and theories have been accumulating for some years but they have been hidden from the general student, for the most part, in a multitude of papers in various languages. It was essential to the progress of this division of botany that this material should be brought together and organized. The task was enormous and has been well performed.

The precise field included in this presentation is the ecology of the individual and not of the formation or association. It may therefore be denominated "morphological and physiological ecology." The classification of materials is suggested by the principal heads which are "roots," "leaves," "stems," "saprophytism and symbiosis," "reproduction and dispersal," "germination," "plant associations," and "adaptations." In general, the development of any topic begins with an account of the structures and functions involved, and proceeds to a discussion of the causative and genetic factors.

The necessity of reviewing the anatomical and physiological facts in the light of their ecological relations makes this volume a great repository data upon those subjects as well as in ecology proper. The secondary teacher will find it an excellent work of reference when in search of those details commonly omitted in text-books. The wealth of data is so great that it may be a bit confusing to the college student with a limited perspective. This fault, however, must not be charged up to the author but to the present undeveloped state of the science. There are many ecological theories, but as yet none of them organize the subject in the sense that morphology is organized about the theory of evolution.

The author has been particularly careful to avoid all teleological phraseology or implications. Many of us will witness the demolition of our idols with regret, for some of them were useful class room properties. The views advanced regarding the interpretation of so-called adaptations are those that have been held by advanced workers for some years but their inclusion in a standard text-book will give them a currency which they have previously lacked. It may be expected to result in greater clearness in botanical thought and teaching.

The avoidance of terms with purposive implications has been carried so far as to exclude such familiar friends as "adaptation," "regulation," "entomophilous," "competition," and "function."

It will be a distinct disappointment to many teachers that physiographic ecology is not included. The author has been so prominently identified with this phase of ecology from its inception in this country that considerably more was expected than the eight-page summary which appears in the book.

It is no exaggeration to say that the publication of this book should mark a distinct step in advance in the teaching of botany in America. Ecology has already profoundly influenced the secondary school course but outworn and teleological explanations of structure and function have remained. This has been due in part to the absence of any available extended statement of the modern attitude whereby the teacher who is not a specialist in ecology might square his practice. Every progressive teacher must now familiarize himself with this presentation of the ecological viewpoint. W. L. E.

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Farmers of Forty Centuries, or Permanent Agriculture in China, Korea and Japan. By F. H. King, recently Professor of Agricultural Physics and Chief of the Division of Soil Management in the University of Wisconsin. 441 pages with 248 illustrations. Published by Mrs. F. H. King, Madison, Wisconsin.

This is one of the most interesting, instructive, readable and convincing of books, and deals with a subject of such importance that we in a relatively new country surely need to heed the lessons with which it is filled. It is the outcome of a prolonged and systematic study of agriculture in China, Korea, and Japan. The author's many years of study of soil problems fitted him especially for the preparation of this book. Furthermore, it is peculiarly appropriate that the last published work from a man who has done so much for agriculture should have to do with a comparative statement of soil fertility in very old and new civilizations, and admonition to our own country to profit by the experience of the "Farmers of Forty Centuries."

In the United States we often talk of our methods of intensive agriculture, but how elementary this is appears when we note the fact that Japan has a population of 2,349 to each square mile of cultivated land, over three to each acre, and withal her balance of import over export of agricultural products is less than one dollar per capita. The island of Chunming in the mouth of the Yangtse river, an island of 270 square miles with but one large city, supports a population of 3,700 people per square mile. In these three countries with a climate scarcely more favorable than that of the United States, nearly "500,000,000 people are being maintained, chiefly upon the products of an area smaller than the improved farm lands of the United States." It is obvious that there must be great destruction of human life when any considerable portion of countries so densely populated fails in its crops. The whole book is a story of never-ending industry and watchfulness; of conservation of water, soil, sunlight, plant, and animal products; of conservation of time, and of learning regarding productivity.

Plant and animal (including human) refuse is regularly composted in such ways as to make it readily useful when placed in the fields of growing crops. In the better regions the crops can scarcely be said to follow one another through the growing season, since they are telescoped into one another. For example: in a wheat field with the wheat nearing harvest, cotton was just getting started; in another field the wheat was almost ready for harvest, windsor beans were half-grown and cotton had just been planted; in another field with a crop of barley just harvested, Chinese clover (*Medicago denticulata*) had been grown and was about to be turned under to be followed by cotton; rice and many other plants are started in seed beds and when partly grown are transplanted when the fields are cleared from the preceding crops, thus saving much time. Weeds and unused parts of other plants—even the roots of wheat—are used in making composts.

We cannot discuss the canals of China, the tea industry, silk production, rice culture, nor other topics presented in the book. The author makes it quite clear that China loses much soil through erosion, that there are many unsolved agricultural problems. He does not claim that methods that have succeeded so well in the East necessarily are to be adopted here; but they certainly are worthy of consideration and probably of trial. The book should dignify Eastern agriculture, and help to save us from the bigotry which often leads us to the conclusion that we are the most intelligent agriculturalists, when in fact we merely have the first chance at wide expanses of the most productive virgin soil from which our crude and wasteful methods give us large returns. O. W. C.